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A PROPOSAL TO STUDY THE INSECT FAUNA
OF
WALNUT CREEK NATIONAL WILDLIFE REFUGE
PRAIRIE CITY, IOWA

Submitted to:

U.S. Fish and Wildlife Service
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ABSTRACT

The Walnut Creek Wildlife Refuge (Prairie City, Iowa) has initiated a tallgrass prairie restoration on its property. The refuge consists of a complex of native habitat remnants and agricultural lands. A primary goal of this restoration project is to return agricultural lands to a native vegetative cover. A related goal is to identify fauna associated with the remnant natural communities and monitor their response to restoration and management efforts.

It is the purpose of this proposed study to identify target insect fauna on the Walnut Creek National Wildlife Refuge by completing a comprehensive surveys of remnant habitats on the refuge. The survey will identify rare, threatened, and endangered insects in remnant habitats. The survey should also serve to characterize habitats by the species complement present.

The data obtained by this survey may be used in a number of ways:

- Assess the quality of the existing remnant habitat patches
- Aid development of management strategies for restoration of remnant habitats and for restoration/creation of native habitats on old agricultural lands
- Aid in determining the success, over time, of habitat restoration, creation, and management activities
- Aid in management for rare, threatened, and endangered species

1.0 INTRODUCTION

Recent increased interest in biological diversity and the factors regulating the distribution of organisms has prompted numerous studies of species assemblages in native habitats (Lubchenco et. al., 1991). North American grasslands are of particular interest because of the large-scale conversion of these habitats to agriculture lands and residential areas. Grasslands contain a rich and varied flora, within which herbivorous insects have evolved a wide array of specialized feeding strategies. These communities represent excellent opportunities to study relationships between insects and their host plants (Cwikla and Blocker, 1981; Hardwick, 1958; Kemp et. al., 1990; Lafontaine, 1987; Morris, 1990; Nagel, 1979; Panzer, 1984, 1988; Panzer and Derkovitz, 1990; Whitcomb, et. al., 1986, 1987a).

In Illinois, 99.99% of the original vegetative cover has been destroyed; the remaining 0.01% consists of highly fragmented, isolated habitat islands. Similar habitat conversions have occurred throughout the Great Plains. By carefully studying prairie remnants, researchers have identified species of insects that are dependent upon native grasslands for survival. Often this is because the insect is dependant upon a particular foodplant or host. However, the species may be dependent upon vegetative structure, and historical uses of a grassland often affect the species complement that remains. Fire, grazing, and cultivation have profound effects on the floral and faunal structure of a grassland; land use practices may extirpate some species while increasing the abundance of others (Evans, 1991; Kemp et. al., 1990; Ricklefs, 1987; Waloff, 1980).

Insects dependant upon remnants of prairie habitat are of interest for several reasons. First, because remnant habitats are, by definition, limited in abundance, they are relatively unique and therefore are likely to harbor unique species. Indeed, there are many endangered and threatened insects indigenous to native grasslands. Second, assessing the assemblage of remnant-dependant species may be helpful in determining the quality of a remnant. In addition, the assemblage of species may aid in the development of restoration management strategies. Ineffective or potentially damaging management tactics may be employed if diligent effort has not been made to identify the full complement of remnant-dependent species, most of which are sedentary herbivores, restricted to one or a few host plants. Many overwinter above-ground as adults, larvae, ova, or pupae, and thus are susceptible to environmental extremes (winds and temperature) and management practices such as burning. Finally, the species complement in remnant areas provides baseline data against which the success of management alternatives can be gauged. Management strategies that attend to the needs of an assemblage of species help ensure survival of entire communities, not just select members of it.

2.0 PROJECT OBJECTIVES

1. Complete comprehensive surveys of remnant habitats on the refuge to identify target species in each habitat area/type and to characterize habitats by the species complement present.
2. Use these data to assess the quality of the existing remnant habitat patches.
3. Use these data to aid in development of management strategies for restoration of remnant habitats and for restoration/creation of native habitats on old agricultural lands.
4. Organize and interpret these data so that they will be helpful in determining the success, over time, of habitat restoration, creation, and management activities.
5. Use the survey to search for rare, threatened, and endangered species in remnant habitats, and incorporate these results into numbers 2-4 above.

3.0 STUDY PARAMETERS

3.1 COMMUNITY SURVEYS

The Walnut Creek National Wildlife Refuge contains small, isolated parcels of prairie, savanna, and wetland habitats. They are set in a matrix of agricultural lands, which make up the largest part of the 8,600 acre refuge.

A survey for species dependent on habitat remnants will require sampling for a variety of insect groups in each habitat type. A list of species known from tallgrass prairie complexes is given in Table 1.

The following section identifies the insect groups to be used in this study and reasons they were selected.

3.2 TAXONOMIC GROUPS TO BE STUDIED

Of the insect groups associated with North American grasslands, the orders Homoptera (plant hoppers, leafhoppers, cicadas) and Lepidoptera (Butterflies, skippers, and moths) appear to contain many species that are restricted in their habitat preferences (Hardwick, 1958; LaFontaine, 1987; Panzer, 1988, 1990; Shuey, 1985; Whitcomb, et. al., 1986, 1987a-b). All appear to be sensitive to changes in plant species composition and vegetative structure, especially on small sites. Thus, these insects are good indicators of habitat quality for both existing habitat remnants and when monitoring the effects of restoration activities.

Table 1. Insects dependant upon the tallgrass prairie ecosystem.

| Species | Wetland | Habitat Association Savanna | Prairie |
|-----------------------------------|---------|--------------------------------|---------|
| Order ODONATA | | | |
| Family Gomphidae | | | |
| <u>Gomphus quadrilineatus</u> | * | | |
| <u>Somatochlora hineana</u> | * | | |
| Order ORTHOPTERA | | | |
| Family Acrididae | | | |
| <u>Eritettix simplex</u> | | * | * |
| <u>Hesperotettix viridis</u> | | * | * |
| <u>Mermiria bivittata</u> | | * | * |
| <u>Pseudopomala brachyptera</u> | * | * | * |
| <u>Syrbula admirabilis</u> | | * | * |
| Family Gryllotalpidae | | | |
| <u>Gryllotalpa major</u> | | | * |
| Order HOMOPTERA | | | |
| Family Cicadellidae | | | |
| Genus <u>Chlorotettix</u> | * | * | * |
| <u>Comellus sexvittatus</u> | | | * |
| <u>Dorycephalus platyrhynchus</u> | | | * |
| <u>Elymana acuma</u> | | * | * |
| Genus <u>Flexamia</u> | * | * | * |
| <u>Hecalus curtus</u> | * | | * |
| <u>H. flavidus</u> | * | * | * |
| <u>H. kansiensis</u> | * | | |
| <u>H. lineatus</u> | * | | |
| <u>H. major</u> | * | | |
| Genus <u>Laevicephalus</u> | * | * | * |
| Genus <u>Limotettix</u> | * | | * |
| <u>Mesamia nigradorsum</u> | | * | * |
| <u>M. coloradensis</u> | | | * |
| <u>M. straminea</u> | | | * |
| Genus <u>Osbornellus</u> | | * | |
| Genus <u>Paraphlepsius</u> | * | * | * |
| Genus <u>Polyamia</u> | | * | * |
| <u>Prairiana kansana</u> | | * | * |
| Genus <u>Scaphoideus</u> | | * | |
| Order HOMOPTERA | | | |
| Family Cicadellidae | | | |
| <u>Xerophloea major</u> | | * | * |
| <u>X. viridis</u> | | | * |
| Order LEPIDOPTERA | | | |
| Family Arctiidae | | | |
| <u>Cycnia inopinatus</u> | | * | * |

Table 1. Insects dependant upon the tallgrass prairie ecosystem (continued).

| Species | Wetland | Habitat Association Savanna | Prairie |
|-------------------------------|---------|--------------------------------|---------|
| <u>Pygarrctia spraugei</u> | | * | |
| Family Hesperidae | | | |
| <u>Achalarus lyciades</u> | | * | |
| <u>Atrytone aroqos</u> | | | * |
| <u>Atrytonopsis hianna</u> | | * | * |
| <u>Euphyes bimacula</u> | * | | |
| <u>Euphyes conspicua</u> | * | | |
| <u>Euphyes dion dion</u> | * | | |
| <u>Hesperia dakota</u> | | | * |
| <u>H. leonardus leonardus</u> | | * | * |
| <u>H. leonardus pawnee</u> | | | * |
| <u>Hesperia metea</u> | | * | * |
| <u>H. ottoe</u> | | | * |
| <u>Poanes massasoit</u> | * | | |
| <u>P. viator</u> | * | | |
| <u>Problema byssus</u> | * | | |
| Family Noctuidae | | | |
| Genus <u>Apamea</u> | * | | * |
| <u>Catocala abbreviatella</u> | | * | * |
| <u>C. amestris</u> | | * | * |
| <u>C. consors</u> | | * | |
| <u>C. dulciola</u> | | * | |
| <u>C. nuptialis</u> | | * | * |
| <u>C. pretiosa</u> | | * | |
| <u>C. whitneyi</u> | | * | * |
| <u>Euxoa immixta</u> | | * | |
| <u>E. oberfoelli</u> | | | * |
| <u>Iodopepla u-album</u> | | * | * |
| <u>Luperina stipata</u> | * | | |
| Genus <u>Machrochilo</u> | * | | * |
| Order LEPIDOPTERA | | | |
| Family Noctuidae | | | |
| Genus <u>Papaipema</u> | * | * | * |
| <u>Paectes abrostolella</u> | | * | * |
| Genus <u>Schinia</u> | | * | * |
| <u>Simyra henrici</u> | * | | |
| <u>Spartiniphaga inops</u> | * | | |
| <u>Tricholita notata</u> | | * | * |
| Family Pyralidae | | | |
| subfamily <u>Crambiinae</u> | * | * | * |

Table 1. Insects dependant upon the tallgrass prairie ecosystem (continued).

| Species | Wetland | Habitat Association Savanna | Prairie |
|-------------------------------------|---------|--------------------------------|---------|
| Family <u>Sesiidae</u> | | | |
| Genus <u>Carmenta</u> | | * | * |
| Genus <u>Euhagena emphytiformis</u> | | * | * |
| Family <u>Tortricidae</u> | | | |
| Genus <u>Eucosma</u> | | * | * |

We will also survey for members of the order Orthoptera (grasshoppers, katydids, and crickets). Although only a limited number of species are restricted to native habitats, they have a high public profile as pests. The order Odonata (dragonflies and damselflies) is a large group of water-dependant species with many members that select specific habitats and that are sensitive to habitat perturbations. The Odonata will also be sampled to monitor changes in water quality and riparian habitats.

Order Homoptera

Family Cicadellidae:

Studies of a variety of grassland leafhoppers indicate that the genera Athysanella, Chlorotettix, Cicadula, Deltocephalus, Flexamia, Graminella, Hecalus, Laevicephalus, Limotettix, Osbornellus, Paraphlepsius, Polyamia, Scaphoideus, and Texananus contain species that are dependent on remnants of native grassland habitats in the Midwest and Great Plains regions (Bess, 1993; Blocker and Reed, 1976; Hamilton, 1987; Panzer, 1988, 1990; Panzer and Derkovitz, 1990; Whitcomb, 1986, 1987a-b). These genera are relatively large and each contains several species restricted to native habitats. Leafhoppers are found in most grassland and savanna habitats, and they frequently are indicator species for the communities in which they occur.

In his studies of remnant grasslands in Illinois, Panzer (1988) has identified genera and species within the Cicadellidae that are habitat specific. The restricted distribution of grassland leafhoppers is due (in part) to host-plant specificity (often feeding on one or a few species of native grasses - primarily from the genera Andropogon, Aristida, Bouteloua, Muhlenbergia, and Sporobolus, rushes - Eleocharis and Scirpus, and sedges - primarily Carex). Several groups of leafhoppers appear to be sedentary and some are also brachypterous, limiting the speed with which they can colonize new habitat (DeLong, 1948; Beirne, 1956; Whitcomb, 1986). Leafhoppers overwinter as ova, nymphs, or adults at the base of the foodplant and they are fire sensitive.

The genera Cicadulla, Chlorotettix, Graminella, Hecalus, and Laevicephalus tend to be associated with marshes and mesic grasslands dominated by Gramminoid and Cyperoid plants. Nearly all feed on species of Andropogon, Calamagrostis, Carex (primarily Carex aquatilis, C. lacustris, and C. stricta), Eleocharis, Elymus, Muhlenbergia, and Scleria. These genera are most diverse in mesic to wet tallgrass prairies and prairie fens of the northern Midwest states (DeLong, 1948).

Leafhoppers from the genera Flexamia and Polyamia appear to be restricted to specific habitats, with the greatest species diversity in the tallgrass prairies of Iowa, Kansas, Missouri, Nebraska, and Oklahoma. The Flexamia feed entirely on grasses of the tribes Andropogoneae, Aristideae, and Chlorideae. In the Midwest are found F. areolata and F. atlantica on Panicum spp., F. picta and F. pyrops on Aristida spp., F. imputans and F. huroni nov. sp. on Muhlenbergia spp., F. reflexa, and F. prairiana on Andropogon spp., and F. delongi, F. clayi, and F. sandersi on Schizachyrium scoparium (Bess and Hamilton, 1993; DeLong, 1948; Whitcomb and Hicks, 1988).

Polyamia (with the exception of weedi) appear to be associated exclusively with species of Panicum and Andropogon. Flexamia prefer dry to mesic prairie, while Polyamia occur in greatest numbers in more xeric prairies and glades dominated by Panicum and Andropogon spp. (DeLong, 1926, 1948; Whitcomb and Hicks, 1988).

The genera Osbornellus, Paraphlepsius, and Scaphoideus also contain species restricted to native grassland habitats. Most feed on herbaceous perennials, primarily the Asteraceae, and several appear to be grassland-savanna obligates (DeLong, 1948; Panzer, unpub. MS). The genus Paraphlepsius contains many species associated with wetlands, but some are found in mesic to xeric prairies and oak savannas. The genera Osbornellus and Scaphoideus are associated primarily with oak savanna and oak barren communities in the midwestern and southeastern United States and southern Canada. The genus Cloanthanus (= Scaphytopius) also contains species restricted to undisturbed remnants of native grasslands. With additional research, other genera restricted to specific habitats are likely to be found.

Order Lepidoptera

Family HesperIIDae

Within the HesperIIDae (skippers), the genera Atrytone, Atrytonopsis, and Hesperia are largely confined to native grasslands; some species apparently occupy a very narrow niche. Atrytone aroqos, A. logan, Atrytonopsis hianna, Hesperia dakota, H. leonardus, H. metea, H. ottoe, and H. sassacus are generally restricted to native grassland of the North American Great Plains. Other grassland-obligate species include Achalarus lyciades, Problema byssus, Thorybes bathyllus, and some species in the genus Erynnis.

Hydric grasslands on Walnut Creek National Wildlife Refuge, dominated by Cyperaceae, are likely to contain species of HesperIIDae. The genera Euphyes and Poanes contain several species that are restricted to native grasslands within the Great Plains. Euphyes dion and E. conspicua are widely distributed geographically, but are restricted to native grasslands. As larva they feed on Carex lacustris and C. stricta. Euphyes bimacula is very rare across its range; it is found only where narrow-leaved sedges such as Carex lasiocarpa and C. aquatilis provide a food source. It appears to be associated with alkaline wetlands such as fens. Poanes massasoit and P. viator are also very local in occurrence, and are at the edges of their distributions in the Great Plains region. Larvae of Poanes viator have been collected from Leersia spp. (ricegrass).

Family Noctuidae

The Noctuidae (cutworm moths and their relatives) includes many groups associated with North American grasslands. Of these, the genera Apamea (= Septis), Catocala, Hypocoena, Luperina, Machrochilo, Papaipema, Schinia, and Spartiniphaga, are thought to be entirely or primarily dependant upon remnants of native habitat (Bess, 1993; Panzer, 1988; Lafontaine, 1989).

The genera Papaipema and Schinia include many species that are restricted to single genera or species of plant for larval development. The foodplants are also restricted to, and indicative of, undisturbed native grasslands and herbaceous wetlands.

The genus Papaipema is a rather large (ca. 50 North American species); many species are found only on undisturbed grassland remnants (Bess, 1990; Panzer and Derkovitz, 1990). Papaipema beeriana (a Liatris feeder), P. birdi (larvae found in several species of Apiaceae), P. eryngii (a Global Category 1 species with larvae in Eryngium), P. rigida (larvae in Helianthus and Helenium), P. necopina (larvae in Helianthus), P. maritima (larvae in Helianthus and Cacalia), P. silphii (larvae in Silphium), and P. sciata (larvae in Veronicastrum), are in this category (Bess, 1990; Panzer, 1988; Panzer and Derkovitz, 1990; Panzer and Stillwaugh, 1991). These moths overwinter as ova on dead vegetation and are very sensitive to autumn and spring fires.

As adults, moths in the genus Schinia usually pollinate the host plant that supplies the developing fruit and seeds eaten by the larvae (Hardwick, 1958). Species such as Schinia bina (larvae unknown), S. gloriosa (larvae on Liatris), S. quarae (larvae on Guara spp.), S. jaguarina (larvae unknown), S. lucens (larvae on Amorpha canescens), S. nundina (larvae on Solidago speciosa), S. oleagina (larvae on Kuhnia eupatoroides), and S. septentrionalis (larvae on Aster azureus) appear to be dependant on remnants of native habitat in eastern and central North America. Their pupae overwinter underground and are relatively fire insensitive.

The genera Apamea, Euxoa, Hypocoena, Luperina, Macrochilo, and Spartiniphaga contain species that appear to be restricted to various species of Poaceae and Cyperaceae for larval development. Little is known about host affinities, but the occurrence of many of these moths appears to be highly localized. In the Midwest and Atlantic Coastal Plain states, Euxoa aurulenta, E. bostoniensis, E. fumalis, E. immixta, E. oberfoelli, and E. violaris, are associated with oak barrens, dry-mesic prairie, and/or dune communities. Several species of Euxoa have been taken only sporadically in the last 25 years, possibly due to anthropogenic habitat changes. These moths overwinter above ground as partially grown larvae or ova and are fire sensitive.

The genera Hypocoena, Macrochilo, and Spartiniphaga are associated with mesic and hydric grasslands. Hypocoena enervata and H. bivitatta are very restricted in occurrence and have been proposed for listing as threatened by the state of Ohio (Case et al., 1989). Spartiniphaga inops is restricted to wetlands containing the sole larval host, Spartina pectinata. In Michigan, isolated colonies have been found in wet-mesic sand prairie and wet-mesic tallgrass prairie. In Michigan, it is a species of special concern. In Ohio, Spartiniphaga inops is associated with wet lakeplain prairie remnants and a state listing of threatened has been proposed.

The closely related Spartiniphaga panatela is found in a wider range of grassland types, and has been reported from acidic bogs, prairie fens, and wet-mesic sand prairies (Forbes, 1954; Bess, 1990). Macrochilo absorptalis,

and other species in this genus, appear to feed on Carex spp. They are rare and local throughout their ranges.

Moths of the genera Apamea and Luperina are borers as larvae, but foodplant documentation is lacking for many species. Both groups of moths appear to be associated with hydric to mesic grasslands, and some are found only in native grasslands (Bess, 1990). Apamea smythi, a Federal Category 2 candidate, occurs in the same geographic area as Walnut Creek National Wildlife Refuge. Luperina stipata and L. obtusa appear to be restricted to more wet/mesic grasslands and they are rare and local throughout their ranges (northeastern United States west to the Rocky Mountains). Other members of the genus (i.e. L. passer) are more widespread, but apparently prefer graminoid wetlands of high quality (Bess, 1990).

In the Great Plains, several moths of the genus Catocala are restricted to a specific host plant. As larvae, several species eat Amorpha canescens. Of these, Catocala abbreviatella, C. amestris, C. nuptialis, and C. whitneyi have been recorded from Iowa and appear to be restricted to native prairies. Other species that may occur at the Wildlife Refuge, and which may be remnant dependent, include Catocala consors, C. dulciola, and C. pretiosa/texarkana.

Family Pyralidae

Within the Pyralidae, the genus Crambus and related genera are often abundant in grasslands. The larvae appear to feed on various grasses and sedges, webbing together leaves to form silken shelters. Many species are widely distributed, but several appear to be restricted to particular types of grasslands.

Family Tortricidae

In the Tortricidae, the genus Eucosma contains several species that are clearly associated with remnant native grasslands. The larvae of Eucosma bipuctella and E. giganteana bore into the lower stems and rootstocks of Silphium spp. Thus, the distribution of these insects is limited by the distribution of the host plants.

Family Sesiidae

Larvae in the family Sesiidae feed by boring into the stems and rootstocks of their foodplants; most species are restricted to a single species or genus of plants (Eichlin and Duckworth, 1988). Several species feed exclusively on genera that are found only in native grasslands. Examples are Carmenta anthracipennis (larvae use Liatris), Carmenta bassiformis (larvae use Vernonia), Carmenta ithacae (larvae use Heliopsis and Helenium), Carmenta pyralidiformis (larvae use Eupatorium), and Euhagena emphytiformis (larvae use Guara fillipes); (Eichlin, 1989; Engelhardt, 1946).

Order Orthoptera

Family Acrididae

Species that are very restricted in the habitat they use include Eritettix simplex, Hesperotettix viridis, Mermiria bivitatta, and Pseudopomala brachyptera. Other species such as Hippiscus ocelote, Orphulella pelidna, Syrbula admirabilis, and Trachyrachis kiowa, may be habitat restricted through at least parts of their ranges (Bess, 1993a; Blatchley, 1920; Otte, 1981, 1984; Panzer, 1988).

Eritettix simplex, Hesperotettix viridis, and Mermiria bivitatta are associated with dry to mesic prairie, primarily in the Great Plains. H. viridis appears to be very selective in its choice of foodplants, and is monophagous or oligophagous on various Asteraceae. Ambrosia, Chrysothamnus, and Guetterezia are eaten in the west (Capinera and Sechrist, 1982; Pfadt, 1989).

In Kentucky, Mermiria bivitatta is found only in large clumps of Andropogon gerardii, A. virginica, and Schizachyrium scoparium on undisturbed limestone glades (Bess, 1993a). In northern Illinois, Blatchley (1920) reported that this grasshopper is restricted to dune communities dominated by Andropogon. Capinera and Sechrist (1982) report M. bivitatta feeding on Andropogon, Bouteloua, Calamovilfa, and Elymus.

Pseudopomala brachyptera is found only in remnant native grasslands in Illinois, and it is most abundant on xeric hill prairies. In Michigan, this species has been recorded from xeric grasslands dominated by Schizachyrium scoparium and prairie fens dominated Andropogon (Cantrall, 1968; Bess, pers. obs.). Orphulella pelidna also appears to be restricted to native grasslands in Michigan and Indiana, where it has only been found in openings dominated by Schizachyrium when the openings border wetlands in oak barrens (Blatchley, 1920; Cantrall, 1968; Ballard and Bess, pers. obs.). However, in other portions of its range O. pelidna can be found in a much greater diversity of habitats (Otte, 1981).

Hippiscus ocelote and Trachyrachis kiowa apparently are most abundant in remnants of native xeric grasslands containing large areas of exposed bedrock or gravel. However, smaller numbers may be found in habitats such as roadsides, rock quarries, and old fields (Blatchley, 1920; Cantrall, 1968; Otte, 1984). Male grasshoppers use exposed bedrock and patches of bare gravel for courtship displays (Blatchley, 1920; Cantrall, 1968; Otte, 1981, 1984). Syrbula admirabilis is an inhabitant of xeric grasslands and may be an indicator of high-quality remnant habitats.

Family Gryllotalpidae

This family, the mole crickets, contains several species that are specific in their habitat requirements. Of these, the prairie mole cricket (Gryllotalpa major) appears to be one of the most restrictive. This species, originally reported from several states in the Great Plains region,

was thought to have gone extinct about 30 years ago. It was recently found in Missouri where it is restricted to remnants of the once vast tallgrass prairie.

Order Odonata

Odonata larvae are aquatic and are sensitive to changes in water quality. The distribution of many species is restricted by the habitats they occupy. The family Gomphidae use a very selective habitat; the naiads of most species require flowing water. Many of these species are restricted to a particular size of stream or river. In addition, these species use a specific habitat within the stream, usually sand beds above and below riffles.

Family Gomphidae

Of the habitat-restricted Gomphidae, Gomphus quadrilineatus and Somatochlora hineana occur in the northern Great Plains. Capture of these species is easiest when they are naiads. They are captured by using kick nets in the sand beds of streams. Adults can be caught with aerial nets during the daytime, as they forage for small insects along waterways. Both techniques will be used to survey for these species during the course of this study.

3.3 ESTABLISHING BASELINE DATA

The main goal of this survey is to provide baseline data on the insect fauna of the Walnut Creek National Wildlife Area. These data, and the analysis of the data will be sufficient to meet the goals stated in Section 2.0 above.

Briefly, data will be sufficient to both identify the species within a habitat, and to characterize the habitat by its species complement. Both individual species and the assemblage of species may be characterized as dependant upon remnant native habitats within the refuge. Because of this dependance, some species may be considered rare, or classified as threatened or endangered. Because of the presence of particular species or species assemblage, some areas may be considered of greater quality, value, or desirability than others.

When an assessment of habitat quality (value and/or desirability) is made, data that describe this habitat can be used to guide restoration and management alternatives, and to assess the product of restoration/management activities.

3.4 DEVELOPING MANAGEMENT RECOMMENDATIONS

The baseline data gathered during the initial survey will provide information important for future restoration and management decisions. Restoration and management of the refuge's habitats will include many factors in addition to insects. However, the insect survey will provide

additional, and potentially unique data that may support some management strategies or techniques over others.

Restoration and management efforts may target individual species that are rare, threatened, or endangered, or they may target development of the "highest quality" habitat for the area. In either case, incorporating the data obtained from the insect survey is likely to assure that the expressed goals of restoration are met.

3.5 ASSESSING THE SUCCESS OF RESTORATION AND MANAGEMENT ACTIVITIES

Regardless of restoration and management objectives, a mechanism to measure the success at achieving those goals is desirable. A pre-restoration survey, such as that proposed here, will provide data required for a comparison of pre-restoration conditions with restoration monitoring and post-restoration results. Monitoring will provide a measure of changes occurring throughout the restoration effort that can be used to enhance effective management techniques and reduce or avoid the use of strategies that are ineffective or harmful.

3.6 LITERATURE CITED

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4.0 Methods

Insect diversity and abundance varies both spatially and temporally. In addition, there is a turn-over of species with time. Thus, an important part of a survey for insects is a redundancy in sampling effort. The field survey effort will be repeated in early to mid-spring, early summer, late summer, and autumn. The sampling periods follow the phenology of grassland insects of the northern Great Plains.

At this time we are projecting that each survey will last a total of 10 field days for an entomologist and a field technician, for a total of 20 person-days of field effort. Eighty person-days of effort will be expended during the four field efforts. However, the actual level of effort to be expended will depend upon the number of locations that the refuge would like to have sampled for the pre-restoration database. In general, the finer the resolution of restoration, the greater the effort required for the pre-restoration survey. The degree to which success of restoration is measured will also determine the effort required for pre-restoration surveys.

The survey will employ four types of sampling: sweep netting, aerial netting, kick netting (of odonates), and ultraviolet light trapping.

Statistical analysis can be applied to insects collected using sweep nets if the method and number of sweeps are standardized. Sweep netting will be conducted along randomly selected transects within the habitat being sampled. Samples will be taken on ecotones and in central portions of the habitat in order to collect the greatest number of species. Ecotonal areas are often centers of diversity and may contain species not found elsewhere. Ecotones often contain most of the nectar plants, which are crucial for insects dependant upon a nectar diet.

Insects from sweep net samples are euthanized with ethyl ether and placed into individual zip-loc bags. The bag is labelled in indelible ink, identifying the location and time of capture, temperature, and cloud cover. The samples are then placed in a cooler for transport to the laboratory, where they will be dried and sorted for homopteran and orthopteran.

Aerial nets will be used to catch voucher specimens of day-flying lepidopteran, odonate, and orthopteran. Statistical analysis cannot be applied to data collected using this method.

Kick nets and seines will be used to sample for Odonata nymphs. This technique consists of holding an aquatic net downstream from the area to be sampled, and disturbing the substrate to dislodge insects buried in the sand and gravel. Insects are removed from the net and placed in alcohol for storage. All samples are labelled with the place of collection, date, time of day, and substrate.

Ultraviolet light traps will be used to capture nocturnal lepidopteran and homopteran. These traps consist of a battery-powered ultraviolet light

placed above a container used to collect the insects. The ultraviolet light acts as an attractant for the insects, and they are directed into the collecting container by vanes and a funnel. Ultraviolet light traps will be placed in a variety of habitats. The ultraviolet light trap is used for determining the presence or absence of indicator species. Statistical analysis cannot be applied to samples obtained with this method.

5.0 TIMETABLE

The following is an outline of the time needed to complete the surveys and to process the samples that are collected.

Surveys will be conducted in early May, late June, mid-August, and late September. Samples will be sorted (and insect species identified) immediately following return to the laboratory.

| | |
|--|----------|
| One Entomologist and one field technician for four, 10-day field surveys. | 80 days |
| One Entomologist for analysis of sweep net samples (20 days per sample period) | 80 days |
| Report write-up. | 40 days |
| | <hr/> |
| Total: | 200 days |

6.0 WORK PRODUCTS

This survey will provide Walnut Creek National Wildlife Refuge with baseline data on the insect fauna occurring on their lands. These data will be analyzed and provided to the refuge in an interpretive report. The report will identify all target species collected in each community, and will characterize the insect community based on these species. The report will assess the quality of the existing remnant habitat patches, based on the insects found there. The report will note rare, threatened, and endangered species encountered during the survey.

The report will note management activities appropriate for individuals, groups of individuals, of a species assemblage. It will not detail a management plan, nor attempt to integrate specific management targets into a plan being developed by the refuge. However, these products can be provided should the refuge so desire.

The report will organize and interpret the survey data so that they will be valuable for comparison with future data sets that may be collected when determining the success of habitat restoration, creation, and management activities.

If the data are appropriate, and with the permission of the refuge, results may be presented at scientific meetings or symposia, or an article may be submitted to a peer-reviewed journal for publication.

7.0 PERSONNEL QUALIFICATIONS

3D/ESI Resume

James A. Bess
Biologist II

EDUCATION

M.S. Entomology, 1993. Montana State University
B.S. Anthropology, 1987. Michigan State University

EXPERIENCE

Mr. Bess serves as a Biologist II with 3D/ESI, where his primary responsibilities include rare and endangered species surveys, habitat monitoring and assessment programs, and the development and implementation of mitigation plans to compensate for impacts to rare and endangered species or their habitat. Mr. Bess is a broadly trained ecologist, but he specializes in the study of insects, especially the orders Homoptera (families Cicadellidae and Cercopidae), Lepidoptera, Odonata, and Orthoptera. He is also an experienced botanist and plant taxonomist, with expertise in the grassland and wetland communities associated with the Rocky Mountain, Midwest, and Great Plains regions. Mr. Bess is experienced in wildlife and vegetation survey techniques, supervising field personnel, scientific data collection and analysis, the preparation of technical reports, and the development and implementation of management plans.

Prior to joining 3D/ESI, Mr. Bess surveyed the remnant grasslands of Kentucky for insects and developed management practices that would promote the survival of rare species. While working for Michigan Natural Heritage Program, Mr. Bess compiled and analyzed data on rare, threatened, and endangered species in Michigan, mapped the distributions of listed species, reviewed private-sector development plans for impacts to rare and endangered organisms, and gave talks to state and federal authorities on the insects of Michigan. Using aerial photographs, topographic maps, known localities for insect species, and previous botanical surveys to identify potential survey sites, he also coordinated and conducted numerous statewide surveys for rare, threatened, and endangered species of insects. Mr. Bess updated the database on the insects of Michigan and presented information on rare and endangered species to the state Citizen's Advisory Committee on endangered species. This information led to the listing of several species of insects as threatened or endangered in Michigan and the listing of the Mitchell's satyr (Neonympha mitchellii) as federally endangered.

REPORTS

Bess J. A. 1992. A report on the insect fauna of Kentucky remnant grasslands. Unpubl. Report to The Nature Conservancy, 29 pp. + 8 maps, 3 tables.

- Bess J. A. 1991. An insect survey of Kentucky's remnant grasslands. Unpubl. Report to The Nature Conservancy, 30 pp + 6 maps.
- Bess, J. A. 1990. The insect fauna of Bakertown and Ayton fens. Unpubl. Report to The Nature Conservancy, 32 pp.
- Bess, J. A. 1989. Proposed status changes for Michigan special concern, threatened, and endangered insects. Unpubl. Report to Michigan Department of Natural Resources, East Lansing, 11 pp.
- Bess, J. A. 1989. The status of the Karner blue Butterfly, Lycaeides melissa samuelis Nabakov, in the Manistee National Forest. Unpubl. Report to The Nature Conservancy, 32 pp.
- Bess, J. A. 1987. An insect survey of eight fens in southern Michigan. Unpubl. Report to Michigan Department of Natural Resources, East Lansing, 117 pp.

PUBLICATIONS IN PREPARATION

- Bess, J. A., and K. G. A. Hamilton. A new species of Flexamia (Homoptera: Cicadellidae: Deltocephalinae) from southern Michigan. Submitted to The Canadian Entomologist.

PRESENTATIONS

- Fall 1992. Presented a seminar on the insects of grassland preserves in Kentucky, and their use as monitoring tools in grassland management programs. Entomology Research Laboratory seminar series, Montana State University, Bozeman, Montana.
- Fall 1990. Presented the results of insect surveys conducted in Michigan to the faculty of the Biology Department at The University of Louisville, Kentucky.
- Spring 1990. Addressed the personnel of the Allegan State Forest, Allegan County, Michigan, as to the range, biology, and potential management of Karner Blue butterflies on state forest lands.
- Spring 1990. Presented supporting information on proposed status changes for Michigan threatened and endangered animals to the Michigan Citizen's Advisory Committee on Threatened and Endangered Species.
- Winter 1989. Presented the results of insect surveys conducted in the Manistee National Forest to Forest Service personnel in Newaygo, Michigan.

PROFESSIONAL MEMBERSHIPS

Lepidopterists Society
Ohio Lepidopterists Society
The Nature Conservancy
Natural Areas Association

3D/ESI Resume

Karen Tyrell
Senior Associate
Manager, Endangered Species Program

EDUCATION

Ph.D. Biology, 1990, University of Illinois
B.S. Zoology, 1980, University of Wisconsin
HEP Certified, 1990, USFWS.
Advanced HEP/HSI Software, 1991

EXPERIENCE

Dr. Tyrell is Manager of 3D/ESI's Endangered Species Program and has extensive experience in basic and applied research in a diversity of fields. She has conducted research on such diverse groups of organisms as bats, rodents, primates, shrews, birds, and snakes. Her expertise includes not only the traditional areas of field ecology and ecological theory, but also the recent and dynamic field of behavioral ecology. Dr. Tyrell has completed studies throughout the United States and in Malaysia.

As Program Manager for projects in Endangered Species and Terrestrial Ecology at 3D/ESI, Dr. Tyrell has designed and implemented numerous projects addressing the needs of a variety of private developers, as well as government organizations including the U.S. Fish and Wildlife Service, Department of Energy, Department of Defense, the U.S. Army Corps of Engineers, and many state regulatory agencies. Dr. Tyrell has extensive experience with all phases of project implementation, from study development and design, through coordination of field work and final reporting.

Much of Dr. Tyrell's efforts are directed toward responding to mandates of the National Environmental Policy Act (NEPA) of 1969, which may require consultation for endangered species under Section 7 (a)(2) of the Endangered Species Act of 1973. This mandate ensures that actions authorized, funded, or executed by Federal agencies are not likely to jeopardize endangered species. Dr. Tyrell is experienced with the informal Section 7 consultation occurring at project inception, and also with formal consultation required when endangered species may be in jeopardy. Dr. Tyrell has developed extensive programs to avoid impacts to endangered species through conservation measures, including mitigation for loss of habitat.

Dr. Tyrell is a consulting member of the U.S. Fish and Wildlife Service Recovery Team for federally endangered Indiana and gray bats. She has completed numerous assessments for federal, state and local agencies for endangered bats, and has continuing research efforts associated with both summer and winter aspects of their ecology. She served as Project Manager for a three year study of the summer habitat requirements of the Indiana bat in

Indiana, the product of which is a habitat model based on the USFWS Habitat Evaluation Procedures (HEP).

Under the direction of Dr. Tyrell the first large-scale mitigation for loss of summer habitat for the Federally endangered Indiana bat entails replacement of roost habitat to meet interim (short-term) needs of the species, and creation of wooded habitat for sustained (long-term) needs. Similarly, a recent project has required mitigation (conservation) plans be developed for the Karner blue butterfly to ensure that individuals survive immediate impacts (i.e., reduce the incidental take), and for creation of suitable habitat to meet long-term needs of the species.

Prior to joining 3D/ESI, Dr. Tyrell was an instructor of graduate and undergraduate courses at two major state universities. During this time, she also conducted federally funded basic research on the physiology and ecology of foraging bats. Findings of these studies have been published and presented at scientific meetings, and Dr. Tyrell's work has been very well-received by the scientific community. Dr. Tyrell is presently a Support Faculty member of the Ethology Program at the University of Tennessee at Knoxville.

PUBLICATIONS

- Feng, A. S., and K. Tyrell. 1988. Do signal characteristics determine a bat's ability to avoid obstacles? In: Animal Sonar Processes and Performances. P. Nachtigall and P.W.B. Moore (ed.). Plenum Press, N.Y.
- Tyrell, K. Social behavior in the Malayan false vampire bat (Megaderma spasma). J. Zool. Lond. (submitted).
- Tyrell, K. The function of passive audition and echolocation in surface gleaning by the Malayan false vampire bat (Megaderma spasma). Behav. Ecol. Sociobiol. (submitted).
- Tyrell, K. The use of prey-generated sounds in aerial prey capture by the bat Megaderma spasma. Behav. Ecol. Sociobiol. (submitted).
- Tyrell, K. Megaderma spasma. Mammalian Species Accounts. American Society of Mammalogists. (in prep).
- Tyrell, K., and K. A. Lindstrom. Responses of the short-tailed shrew (Blarina brevicauda) to the odor of meadow vole nests. (in prep).
- Henze, M. K., and K. Tyrell. Prey handling by the Malayan false vampire bat, Megaderma spasma. (in prep).

PUBLISHED ABSTRACTS

- Tyrell, K., and V. Brack, Jr. 1991. Endangered bats of Breckinridge County, Kentucky. Association of Southeast Biologists. Boone, NC.
- Brack, V., Jr., and Tyrell, K. 1992. The status of the endangered Indiana bat (Myotis sodalis) in Indiana. The Wildlife Society. Nashville, IN.
- Miller, P.S., and K. Tyrell. 1990. Bats of the Hoosier National Forest. Indiana Academy of Science. North Manchester, IN. November 2-3
- Tyrell, K. 1987. Differential use of auditory cues in the Malayan false vampire bat (Megaderma spasma). Midwest Regional Animal Behavior Society Meeting. Eastern Illinois University, Charleston, IL. April 11-12.
- Tyrell, K. 1987. The use of various sensory channels by the Malayan false vampire bat (Megaderma spasma). National Animal Behavior Society Meeting. Williams College, Williamstown, MA. June 21-26. Recipient, Founders Award for Poster Papers.
- Tyrell, K. 1987. The use of echolocation and passive audition in foraging by the surface gleaning bat, Megaderma spasma. Seventeenth Annual North American Symposium on Bat Research. Toronto, Canada. October 15-17.
- Tyrell, K. 1988. The use of audition in different foraging strategies by the Malayan false vampire bat, Megaderma spasma. Second International Behavioral Ecology Conference. Vancouver, British Columbia, Canada. October 6-10.
- Tyrell, K. 1988. The use of prey-generated sounds in flycatcher style foraging by Megaderma spasma. Eighteenth Annual North American Symposium on Bat Research. Calgary, Canada. October 13-15.
- Tyrell, K. 1989. Auditory cue use in surface gleaning and flycatching Megaderma spasma. National Animal Behavior Society Meeting. Northern Kentucky University, Highland Heights, MA. June 12-16.
- Paige, K. N., K. Tyrell, T. Juenger, and G. Fuller. 1989. Tracking insect prey from the roost: bats and barometric pressure. Nineteenth Annual North American Symposium on Bat Research. Knoxville, TN. October 19-21.
- Tyrell, K. 1989. A technique for monitoring insect abundance and biomass in real-time. Nineteenth Annual Symposium on Bat Research. Knoxville, TN. October 19-21.

PROJECT EXPERIENCE

- 3D/ESI. 1993. Survey of surface mines for the presence of endangered bats. Report to the State of Pennsylvania Department of Natural Resources, Bureau of Abandoned Mine Reclamation.
- 3D/ESI. 1993. Ecological Risk Assessment: Bat fauna of the Los Alamos National Laboratory and the Santa Fe National Forest, U.S. Department of Energy.
- 3D/ESI. 1993. Western Resources, Kansas: Survey for endangered bats in northeastern Kansas.
- 3D/ESI. 1993. Development of a conservation plan to mitigate for loss of habitat of the Federally endangered Karner blue butterfly at National Steel's Midwest Division, Porter County, Indiana.
- 3D/ESI. 1993-1992. Development, implementation, and monitoring of a plan to mitigate for losses of Indiana bat summer habitat resulting from developments at the Indianapolis International Airport, Marion County, Indiana, for the Indianapolis Airport Authority.
- 3D/ESI. 1993. Survey for endangered species of plants and animals for Columbia Gas of Ohio, Inc., along a pipeline route crossing the Maumee River in Paulding County, Ohio.
- 3D/ESI. 1993. Survey for the red-cockaded woodpecker and its habitat on Talladega National Forest, Shoal Creek Ranger District, Cleburne and Calhoun Counties, Alabama.
- 3D/ESI. 1992. Field investigation to determine the scope and feasibility of study techniques for surveys of the spotted bat at Los Alamos National Laboratory. Report to Los Alamos National Laboratory, U.S. Department of Energy.
- 3D/ESI. 1992. Surveys for the Biological Assessment, and Supplement to the Biological Assessment of potential impacts to habitat of the Karner blue butterfly at National Steel's Midwest Division, Porter County, Indiana.
- 3D/ESI. 1992. Survey for endangered plants and animals, and mist netting survey for endangered bats, at the Cincinnati-Northern Kentucky International Airport.
- 3D/ESI. 1992. Survey for potential Indiana bat (*Myotis sodalis*) habitat at Marathon Pipeline Company's proposed Wabash River crossing in Lawrence County, Illinois and Knox County, Indiana.

- 3D/ESI. 1992. Survey for the endangered false mermaid weed, running buffalo clover, and habitat of the federally endangered Indiana bat along Texas Eastern Pipeline Products' pipeline extension in Boone County, Kentucky.
- 3D/ESI. 1992. Field survey for Indiana bats and their habitat at the Rock Island Army Corps of Engineers dredge placement site at Beardstown, Illinois.
- 3D/ESI. 1992. Mist net and radiotelemetry survey for the endangered Indiana bat on Fort Benjamin Harrison, Indiana, for the U.S. Fish and Wildlife Service.
- 3D/ESI. 1992. Survey of surface mines for the presence of endangered bats. Report to the State of Pennsylvania Department of Natural Resources, Bureau of Abandoned Mine Reclamation.
- 3D/ESI. 1992. Survey of the chiroptofauna of Los Alamos National Environmental Research Park. Report to Los Alamos National Laboratory, U.S. Department of Energy.
- 3D/ESI. 1992. Studies of the endangered Indiana and gray bats for Texas Gas Transmission Corporation's 14-mile Indiana Gas and 87-mile Main Line Expansion project in Kentucky.
- 3D/ESI. 1992. Survey for the presence of endangered bats at summer foraging habitat and winter hibernacula along the extension of Indiana Highway Route 37, Perry County, Indiana.
- 3D/ESI. 1992. Inventory of suitable habitat for the endangered red-cockaded woodpecker on Talladega National Forest, Shoal Creek Ranger District, Cleburne and Calhoun Counties, Alabama.
- 3D/ESI. 1992. Study to determine the feasibility and compatibility of developments by the City of Columbus, Georgia with the existence of the federally endangered red-cockaded woodpecker.
- 3D/ESI. 1991. Field survey for the endangered Indiana and gray bats at crossings of the Tennessee Gas pipeline by the AA-Highway in Kentucky.
- 3D/ESI. 1991. Field survey for the endangered Indiana bat and its summer habitat at the Indianapolis International Airport, Marion County, Indiana.
- 3D/ESI. 1991. Impact of human disturbance on the over-winter weight loss of hibernating Indiana bats in Indiana. Report to Indiana Department of Natural Resources.
- 3D/ESI. 1991. Impact of human disturbance on over-winter weight loss of hibernating Indiana bats, for U.S. Fish and Wildlife Service and Indiana Department of Natural Resources.

- 3D/ESI. 1991. Winter cave census for the Indiana bat in non-Priority I hibernacula in Indiana. Report to Indiana Department of Natural Resources and U.S. Fish and Wildlife Service.
- 3D/ESI. 1991. A field survey and habitat assessment for seven species of Federal and state endangered bats on Fort Benning, Georgia, for Gulf Engineering and Consultants, Inc.
- 3D/ESI. 1991. A survey for the bog turtle, (Clemmys muhlenbergi), for Transcontinental Gas Pipe Line Corporation along their 15-mile proposed Allentown, Pennsylvania Lateral Natural Gas Pipeline.
- 3D/ESI. 1991. A field survey for Parker's pipewort (Eriocaulon parkeri) at the crossing of Rancocas Creek by Transcontinental Gas Pipe Line Corporation's Proposed Mainline Loop and Trenton-Woodbury Natural Gas pipeline.
- 3D/ESI. 1991. Survey at 20 locations for the endangered Indiana Bat along a 206-mile Natural Gas Pipeline in Illinois and Iowa for ENSR Consulting and Engineering.
- 3D/ESI. 1991. Environmental assessment studies for Tenneco Gas and Midwest Gas Corporation's 42-mile Tuscola Lateral Project, Champaign, Vermillion, and Douglas Counties, Illinois. Report to FERC for Tenneco Gas/Midwest Gas Corporations.
- 3D/ESI. 1991. Indiana bat recovery survey and habitat assessment. Statewide environmental assessments for Federal and state endangered and threatened mammals.
- 3D/ESI. 1991. Three year study of the summer habitat requirements of the Indiana bat in Indiana, and construction of a habitat model based on the U.S. Fish and Wildlife Service Habitat Evaluation Procedures (HEP).
- 3D/ESI. 1991. Suitability of habitat on the Hoosier National Forest for the endangered Indiana bat. Report to U.S. Forest Service and Indiana Department of Natural Resources.
- 3D/ESI. 1990. Development and implementation of a research design to ascertain the impacts of 14-mile and a 87-mile natural gas transmission lines on the endangered Indiana bat in Kentucky, including development of a habitat model acceptable to the U.S. Fish and Wildlife Service and the Kentucky Department of Fish and Wildlife Resources.
- University of Illinois. 1988. Relationship between barometric pressure, insect abundance, and bat foraging activity.
- North Carolina State Museum of Natural Sciences. 1986. Assessment of habitat use, foraging behavior, and distribution of Rafinesque's big-eared bats.

University of Illinois. 1986. Adult responses to neonatal ultrasonic vocalizations in two species of Arctic microtine rodents.

ACADEMIC GRANTS AND AWARDS

National Institute of Health Fellowship
University of Illinois Research Board Grant
University of Illinois Biomedical Research Support Grant
Sigma Xi, Grants-in-Aid of Research
Verdell Frazier Young Award
Animal Behavior Society Founders Award
American Society of Mammalogists Grants-in-Aid
University of Illinois Graduate College Dissertation Research Grant
University of Illinois Graduate College Conference Travel Support Grant
Edwin M. Banks Memorial Award for Graduate Research in Animal Behavior
University of Illinois Graduate College Thesis/Project Support Grant
University of Illinois List of Teachers Ranked as Excellent
University of Illinois Outstanding Teacher

PROFESSIONAL MEMBERSHIPS

American Association for the Advancement of Science
American Institute of Biological Sciences
American Society of Mammalogists
Animal Behavior Society
Association for Women in Science
Association of Southeast Biologists
Indiana Academy of Science
International Society for Behavioral Ecology
Sigma Delta Epsilon/Graduate Women in Science
Sigma Xi

3D/ESI Resume

Virgil W. Brack, Jr.
Executive Vice President
Principal In Charge

EDUCATION

Ph.D. Wildlife Ecology, 1983, Purdue University
M.S. Physiological Ecology, 1979, University of Missouri-Columbia
B.S. Wildlife Sciences, 1975, University of Missouri-Columbia
HEP Certified, 1986, USFWS.

EXPERIENCE

Dr. Brack has extensive experience with the management of multidisciplinary projects. In the recent past he has managed large Environmental Impact Statement (EIS) studies for highway developments, numerous Environmental Assessment (EA) studies for natural gas pipeline corridors and highway projects, environmental studies for hydropower developments, environmental studies for five U.S. Army Corps of Engineers Districts, the Department of Energy, the Environmental Protection Agency, Region 2, and the Department of Defense. In the past three years, Dr. Brack has been Project Manager/Administrator for over 20 natural gas pipeline facility EA studies, each of which entailed a variety of disciplines. Fisheries, wetlands, bathymetric, wildlife, hydrologic, aquatic ecology, and water quality considerations have all figured prominently in many of these studies.

Dr. Brack has been assisting clients meet requirements of the National Environmental Policy Act (NEPA) of 1969 for nearly 15 years. He has extensive experience managing and directing large, multidisciplinary Environmental Impact Statements (EIS), Environmental Assessments (EA), Biological Assessments, baseline environmental studies, applied ecological research for endangered species and wetlands, assessment of contamination, and remediation management. He has assisted clients meet environmental requirements of the U.S. Army Corps of Engineers (COE), U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), FAA, FCC, FERC, and numerous states under NEPA and related laws. He has also managed and directed work directly for many of these same agencies and for DOE and the U.S. Forest Service.

Dr. Brack served as Project Manager for an EIS of U.S. Route 131 in Michigan. That project was multidisciplinary. Functional value assessment of 55 wetlands was completed using the COE "Wetland Evaluation Technique" (WET); delineation was accomplished using the COE Wetland Delineation method. He was Assistant Project Manager for all natural resources technical studies on the Route 13 Relief Route highway in Delaware. That project involved impacts to over 400 wetlands, 143 stream crossings, and 150 miles of highway corridor.

Dr. Brack was Project Manager of environmental studies for an EA for approaches to and bridging of the Ohio River at Maysville, Kentucky, an EA for renovation of the Pentagon complex in Washington, D.C., an EIS for the new Federal DOT building in Washington, D.C., and Task Manager of Terrestrial Ecology for two recent major highway EISs in Virginia. In the past five years, Dr. Brack has been Project Manager/Administrator for over 20 multidisciplinary natural gas pipeline facility EA studies. The largest of these included over 200 miles of corridor plus related facilities.

Dr. Brack is Project Principal for 3D/ESI's largest wetlands creation project at the Indianapolis Airport. The airport's infrastructural expansion calls for the removal of about 100 acres of wetlands, with mitigation at a 4:1 ratio. Dr. Brack is familiar with wetland requirements for determination, delineation, functional value assessment, permitting, restoration, creation, and enhancement.

As Project Manager for studies for hydropower developments along major tributaries of the Ohio and Potomac river, Dr. Brack completed studies over a wide geographic area for fisheries, wetlands, bathymetric, wildlife, hydrologic, aquatic ecology, and water quality. Dr. Brack managed an exhaustive study of fish impingement and entrainment study at Racine Hydroelectric Plant on the Ohio River. Twenty pieces of information were collected on each of 66,640 fish, for 1.3 million data points, analyzed with a variety of statistic techniques. This project was the first large scale assessment of fish mortality through bulb turbines on a warm water river.

Dr. Brack is active in a variety of research areas involving endangered bats, wetlands, wildlife, and habitat evaluation techniques. Working with colleagues, Dr. Brack developed a wetlands habitat assessment technique using avifauna as indicators of habitat quality. This technique was recently published in the journal of "Environmental Management."

Dr. Brack is a member of the U.S. Fish and Wildlife Service Recovery Team for federally endangered bats. He has completed numerous assessments for federal, state and local agencies for endangered bats, and has continuing research efforts associated with both summer and winter aspects of their ecology. He served as Principal Biologist for a three year study of the summer habitat requirements of the Indiana bat in Indiana, the product of which is a habitat model based on the USFWS Habitat Evaluation Procedures (HEP).

PUBLICATIONS

Brack, V., Jr. 1985. The foraging ecology of some bats in Indiana. *Indiana Acad. Sci.*, 94:231-237.

Brack, V., Jr., T. T. Cable, and D. E. Driscoll. 1985. Food Habits of urban kestrels (*Falco sparverius*). *Indiana Acad. Sci.*, 94:607-613.

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- Stihler, C. W., and V. Brack, Jr. 1993. A survey of hibernating bats in Hellhole Cave, Pendleton County, West Virginia. *West Virginia Acad. Sci.*, In Press.
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- Brack, V., Jr., and V. M. Dalton. Foraging ecology of the endangered Virginia big-eared bat. To be submitted to J. Mamm.
- Brack, V., Jr., and M. K. Clark. Food habits of Rafinesque's big-eared bat. To be submitted to Canadian J. Zool.
- Driscoll, D. E., V. Brack, Jr., and T. T. Cable. Use of urban habitat by the American kestrel. To be submitted to the Kansas Acad. Sci.

BOOK CHAPTER

- Brack, V., Jr. 1988. Indiana bat. Pp. 608-622, in Audubon Wildlife Report 1988/1989 (W. J. Chandler and L. Labate, eds.). National Audubon Society (Academic Press), New York, New York, 817 pp.

PROCEEDINGS AND MISCELLANEOUS

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- Rommé, R. R., and V. Brack, Jr. 1989. Hydropower development at fixed crest dams: an evaluation of wetland impacts. Pp. 248-252, in Wetlands and river corridor management, (J.A. Kusler and S. Daly, eds.). Association of Wetland Managers, Berne, New York, 520 pp.
- Josselyn, M. N., K. Bobzien, S. D. Bach., and V. Brack, Jr. 1989. Mitigation of wooded palustrine wetlands: Selecting Mitigation Sites. Pp. 436-440, in Wetlands and river corridor management, (J.A. Kusler and S. Daly, eds.). Association of Wetland Managers, Berne, New York, 520 pp.
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TECHNICAL REPORTS

Brack, V., Jr., K. Tyrell, and K. Dunlap. 1993. A 1992-1993 winter cave census for the Indiana bat (*Myotis sodalis*) in non-Priority I hibernacula in Indiana. Report to Indiana Department of Natural Resources, Division of Fish and Wildlife, Nongame.

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Brack, V., Jr., and T. Larkins. 1989. A summer field survey for the endangered gray bat (*Myotis grisescens*) along Lick Run, for drainage corrections to U. S. Route 31, Clark County, Indiana. Report to Indiana Department of Highways.

Brack, V., Jr., and K. Dunlap. 1989. A 1988 - 1989 winter cave census for the Indiana bat (*Myotis sodalis*) in non-priority I hibernacula in Indiana. Report to Indiana Department of Natural Resources, Division of Fish and Wildlife, Nongame.

Brack, V., Jr., T. Larkins, and K. Dunlap. 1987. Winter 1986-1987 census of non-priority I hibernacula in Indiana and a search for unreported hibernacula of the Indiana bat. Report to Indiana Department of Natural Resources, Division of Fish and Wildlife, Nongame.

Brack, V., Jr., T. Larkins, and S.H. Bell. 1987. The bats of Crane Naval Weapons Support Center, Indiana. Report to Indiana Department of Natural Resources, Division of Fish and Wildlife, Nongame.

Brack, V., Jr. 1985. Census of non-priority I hibernacula of the endangered Indiana bat. Report to Indiana Department of Natural Resources, Division of Fish and Wildlife, Nongame.

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Brack, V., Jr. 1984. Bat survey mine sites #174, Clay County; #20, Clay County; #74, Parke County. Report to Indiana Department of Natural Resources, Division of Reclamation.

Brack, V., Jr., and J. Robb. 1983. Status of the endangered Indiana bat, Myotis sodalis in the impact area of the Mill Creek Run project development along Mill Creek Lafayette, Indiana. Report to the City of Lafayette, Indiana.

Brack, V., Jr., and V.R. Holmes. 1982. Status of the endangered Indiana bat, Myotis sodalis, in the impact area of the proposed interstate 69 crossing of Thornapple River, Eaton County, Michigan. Report to Michigan Department of Transportation.

Brack, V., Jr., and V.R. Holmes. 1982. Determination of presence and habitat suitability for the Indiana bat (Myotis sodalis) along portions of the Kankakee River, Indiana. Report to U.S. Army Corps of Engineers.

Brack, V., Jr., V.R. Holmes, R.E. Mumford. 1982. Status of the endangered bats Myotis grisescens (gray bat) and Myotis sodalis (Indiana bat) in the impact area of the proposed PL-566 channel work in Muddy Fork Creek of Silver Creek Watershed, Clark County, Indiana. Report to Soil Conservation Service.

Cope, J.B., V. Brack, Jr., and J.R. Mills. 1980. Status of the endangered Indiana bat, Myotis sodalis, in the impact area of project number RS-7573(1), relocation of Bridge Number 63, County Road Number 53, Shelby County, Indiana. Report to Shelby County Board of Commissioners.

Brack, V., Jr. 1979. Determination of presence and habitat suitability for the Indiana bat (Myotis sodalis) and gray bat (Myotis grisescens) for portions of three ditches, Big Five Levee and Drainage district, Union and Alexander Counties, Illinois. Report to U.S. Army Corps of Engineers.

STUDIES REQUIRING TECHNICAL INPUT FOR FIELD STUDIES, REPORTING, MANAGEMENT, OR ADMINISTRATION (Many other projects have been administered with limited direct technical input.)

EISs, EAs, AND NEPA DOCUMENTATION

3D/ESI. 1992. Environmental studies for Dayton Power and Light Company's Ohio Power Siting Board requirements for the proposed Clarksburg 345/69 kV substation.

3D/ESI. 1992. Environmental studies for AT&T's Xenia to Cincinnati fiber optic line to meet requirements for the Federal Communication Commission's NEPA requirements.

- 3D/ESI. 1992. Environmental studies for a proposed 75-mile corridor in Kentucky to identify constraints under NEPA for various project alternatives.
- 3D/ESI. 1991. Environmental Impact Statement for a New Federal Department of Transportation building, for U.S. DOT Washington, D.C.
- 3D/ESI. 1991. Environmental Assessment for renovation of the Pentagon Complex, Washington, D.C., U.S. Army Corps of Engineers Baltimore District.
- 3D/ESI. 1991. Preparation of Ohio Power Siting Board Applications for East Ohio Gas Company's two Ashtabula County looping lines. Prepared for East Ohio Gas Company.
- 3D/ESI. 1991. Environmental assessment studies for Tenneco Gas and Midwest Gas Corporation's 42-mile Tuscola Lateral Project, Champaign, Vermillion, and Douglas counties, Illinois. Report to FERC for Tenneco Gas/Midwest Gas Corporation.
- 3D/ESI. 1990. Environmental assessment studies for Texas Gas Transmission Corporation's 32-mile Main Line System Phase II Expansion, Claiborne, Webster, Bossier, and Caddo parishes, Louisiana. Report to FERC for Texas Gas Transmission Corporation.
- 3D/ESI. 1990. Environmental assessment studies for Transcontinental Gas Pipe Line Corporation's 15-mile Allentown Lateral Line, Northampton County, Pennsylvania. Report to FERC for Transcontinental Gas Pipe Line Corporation.
- 3D/ESI. 1990. Environmental assessment studies for CNG Transmission Corporation's 52-mile Project Empire Alternate, Wyoming, Onondaga, Erie, and Chemung counties, New York. Report to FERC for CNG Transmission Corporation.
- 3D/ESI. 1990. Environmental studies at Transcontinental Gas Pipe Line Corporation's Leidy Line Compressor Station #517. Report to FERC for Transcontinental Gas Pipe Line Corporation.
- 3D/ESI. 1990. Environmental assessment studies for CNG Transmission Corporation's 52-mile Project Empire Alternate. Report to FERC for CNG Transmission Corporation.
- 3D/ESI. 1990. Environmental assessment studies for Texas Gas Transmission Corporation's 21.1-mile Main Line System Expansion Claiborne and Lincoln parishes, Louisiana. Report to FERC for Texas Gas Transmission Corporation.
- 3D/ESI. 1990. Environmental studies for Dayton Power and Light Company's rebuild of existing circuit No. 6646 from 69 kV to 138 kV Logan County, Ohio. Report to Ohio Power Siting Board for Dayton Power and Light Company.

3D/ESI. 1990. Environmental assessment studies for Texas Gas Transmission Corporation's looping project alignments at Covington, Tennessee, Kenton, Tennessee, and Calvert City, Kentucky. Report to FERC for Texas Gas Transmission Corporation.

ENDANGERED SPECIES STUDIES, BAs, AND MITIGATION

3D/ESI. 1993 and 1992. Inventory of suitable habitat for the endangered red-cockaded woodpecker on Talladega National Forest, Shoal Creek Ranger District, Cleburne and Calhoun Counties, Alabama.

3D/ESI. 1993. Biological Assessment of potential impacts to habitat of the endangered Karner blue butterfly at National Steel's Midwest Division Portage, Indiana RCRA landfill site.

3D/ESI. 1992. Field survey for Indiana bats and their habitat at the Rock Island Army Corps of Engineers dredge placement site at Beardstown, Illinois.

3D/ESI. 1992. Mist net and radiotelemetry survey for the Endangered Indiana bat on Fort Benjamin Harrison, Indiana, for the U.S. Fish and Wildlife Service.

3D/ESI. 1992. Field survey for the Endangered Indiana bat and endangered running buffalo clover along Texas Eastern Products Pipeline Company's pipeline in Hamilton County, Ohio.

3D/ESI. 1992. Field survey for redback salamander (Plethodon cinereus) and false mermaid-weed (Floerkea proserpinacoides) along TEPPCO's proposed pipeline in Boone County, Kentucky.

3D/ESI. 1992. Spring and autumn surveys of surface mines for the presence of endangered bats. Report to the State of Pennsylvania Department of Natural Resources, and the State of Pennsylvania Bureau of Abandoned Mine Reclamation.

3D/ESI. 1992. Field investigation to determine the scope and feasibility of study techniques for surveys of the spotted bat at Los Alamos National Laboratory. Report to Los Alamos National Laboratory, U.S. Department of Energy.

3D/ESI. 1992. Studies of the Endangered Indiana and gray bats for Texas Gas Transmission Corporation. Field survey for, and development of a habitat model along the 14-mile Indiana Gas project, and the 87-mile Main Line Expansion project in Kentucky. Field survey for potential roost trees for the Indiana bat on Segment 2 of the 14-mile Indiana Gas pipeline. Post-construction monitoring and habitat assessment.

- 3D/ESI. 1992. Survey for the presence of endangered bats at summer foraging habitat and winter hibernacula along the extension of Indiana Highway Route 37, Perry County, Indiana.
- 3D/ESI. 1992. Development, implementation, and monitoring of a plan to mitigate losses of Indiana bat summer habitat resulting from developments at the Indianapolis International Airport, Marion County, Indiana, for the Indianapolis Airport Authority.
- 3D/ESI. 1992. Study to determine the feasibility and compatibility of developments by the City of Columbus, Georgia with the existence of the Federally endangered red-cockaded woodpecker.
- 3D/ESI. 1991. Environmental Assessment studies for Transcontinental Gas Pipe Line Company: (1) Leidy, Pennsylvania compressor station, (2) Carlstadt, New Jersey 0.95-Mile line, and (3) 15-mile line and metering station, Allentown, Pennsylvania lateral.
- 3D/ESI. 1991. Field survey for the Endangered Indiana and gray bats at crossings of the Tennessee Gas pipeline by the AA-Highway in Kentucky.
- 3D/ESI. 1991. Field survey for the Endangered Indiana bat and its summer habitat at the Indianapolis International Airport, Marion county,
- 3D/ESI. 1991. A Field Survey and Habitat Assessment for Seven Species of Federal and State Endangered Bats on Fort Benning, Georgia, for Gulf Engineering and Consultants, Inc. The study also includes a netting survey to elucidate the species of bats that are found on the fort.
- 3D/ESI. 1991. A Field Survey at 20 locations for the Endangered Indiana bat along a 206-mile Natural Gas Pipeline in Illinois and Iowa for ENSR Consulting and Engineering.
- 3D/ESI. 1991. Surveys for the Bog Turtle, (Clemmys muhlenbergi), for Transcontinental Gas Pipe Line Corporation along their 15-mile proposed Allentown, Pennsylvania Lateral Natural Gas Pipeline and mainline Trenton-Woodbury natural gas pipeline.
- 3D/ESI. 1990. A field survey for the endangered red-cockaded woodpecker at Texas Gas Transmission Corporation's proposed 165-foot tie-over line between their Bastrop-26-inch and 30-inch lines, Grant Parish, Louisiana. Report to FERC for Texas Gas Transmission Corporation.
- 3D/ESI. 1990. Suitability of habitat on the Hoosier National Forest for the endangered Indiana bat. Report to the U. S. Forest Service and the Indiana Department of Natural Resources.

3D/ESI. 1990. Impact of human disturbance on overwinter weight loss of hibernating Indiana bats. Report to the U.S. Fish and Wildlife Service and the Indiana Department of Natural Resources.

3D/ESI. 1990. Studies of the endangered Indiana bat along Texas Gas Transmission Corporation's 14-mile and 87-mile lines in Kentucky: (1) Development of a research design, (2) Field survey for and development of a habitat model, (3) 1991 and 1992. Post-Construction survey for endangered bats. Report to USFWS, KDFWR, and FERC for Texas Gas Transmission Corporation.

3D/ESI. 1990. Survey for the endangered bald eagle, Jefferson County, Texas for Natural Gas Pipeline Company of America.

WETLAND DELINEATION, VALUE ASSESSMENT, AND MITIGATION

3D/ESI. 1993. Wetland permitting, mitigation, and long-term monitoring for Cincinnati Airport: restoration and creation of wetlands at the Cincinnati Airport and Northern Kentucky Regional Airport

3D/ESI. 1992. Wetland permitting, mitigation, and long-term monitoring for Indianapolis Airport Authority: restoration and creation of 400 acres of wetlands at the Indianapolis Airport, Marion County, Indiana.

3D/ESI. 1990. Wetland survey and delineation for Transcontinental Gas Pipe Line Company: Valley Road at the crossing of McNerny Branch, Clinton County, Pennsylvania.

3D/ESI. 1990. Wetland survey for proposed U.S. Postal facility at Magothy Bridge Road, Severna Park, Maryland.

CONTAMINANT ASSESSMENT, SAMPLING, AND REMEDIATION MANAGEMENT

3D/ESI. 1992. RCRA closure of Building 26, National Institutes of Health, Bethesda, Maryland.

3D/ESI. 1992. Remediation of mercury contamination at 22 meter stations in the central U.S. for Transcontinental Gas.

TECHNICAL STUDIES COMPLETED/MANAGED/ADMINISTERED PRIOR TO 3D/ESI

1990. Environmental assessment studies for the 15-mile line in Calhoun, Roane, and Kanawha counties, West Virginia. Report to CNG Transmission Corporation, for FERC.

1990. Environmental Assessment reports for construction of proposed Glendale-Cleveland No. 1 36-inch line (78 miles), Arkansas and Mississippi. Report to Texas Gas Transmission Corporation.
1990. Environmental Assessment reports, Exhibits F-I through F-VI, Lebanon to Leidy, Transco Transport. Report to CNG Transmission Corporation.
1989. Environmental Assessment report for proposed construction of facilities (14-mile line) for incremental service to Indiana Gas Corporation. Report to Texas Gas Transmission Corporation.
1989. Environmental Assessment reports for construction of facilities (87-mile line) for the Transco/Texas Gas/CNG Northeastern Project. Report to Texas Gas Transmission Corporation.
1989. Environmental assessment report FERC Exhibits F-I, F-II, F-II, and F-IV for the Beta/Longlake project Indiana, Jefferson, and Clearfield counties, Pennsylvania. Report to CNG Transmission Corporation, for FERC.
1989. Environmental assessment report FERC Exhibits F-I, F-II, F-II, and F-IV for the VNG project: Chambersburg Station Pennsylvania, Lambert Station, West Virginia, and Leesburg Station, Virginia. Report to CNG Transmission Corporation, for FERC.
1989. Environmental assessment report FERC Exhibits F-I, F-II, F-II, and F-IV for the Lebanon to Leidy project, Pennsylvania. Report to CNG Transmission Corporation, for FERC.
1989. Environmental assessment studies report FERC Exhibits F-I, F-II, F-II, and F-IV for the Stuben project, Stuben and Tompkins counties, New York. Report to CNG Transmission Corporation, for FERC.
1989. Environmental assessment studies for the Dry Fork project, West Virginia. Report to CNG Transmission Corporation, for FERC.
1989. A field survey for Running buffalo clover (Trifolium stoloniferum) along AT&T's proposed 13-mile central region portion of Williamstown-Lexington FT "A" fiber optic line in Grant County, Kentucky. Report to Bucher, Willis & Ratliff for the Federal Communications Commission.
1989. A field survey for Running buffalo clover (Trifolium stoloniferum) along AT&T's proposed 33-mile Cincinnati-Williamstown FT "A" fiber optic line in Grant and Kenton counties, Kentucky. Report to Bucher, Willis & Ratliff for the Federal Communications Commission.

1989. A field survey for Running buffalo clover (Trifolium stoloniferum, Muhl.) along a proposed Texas Gas Transmission Corporation transmission corridor in Dearborn County, Indiana and Boone County, Kentucky. Report to Texas Gas Transmission Corporation.
1989. Environmental Assessment Studies FERC Exhibits F-I, F-II, F-III, and F-IV for the PennEast Niagara Cogen Project Potter and Clinton counties, Pennsylvania and Erie County, New York. Report to CNG Transmission Corporation, for FERC.
1989. Environmental Review for M&R facility in Leidy Station, Clinton County, Pennsylvania. Report to CNG Transmission Corporation, for FERC.
1989. A survey for nesting raptors and significant trees, Onondaga and Oswego counties, New York. Report to CNG Transmission Corporation, for FERC.
1989. Water quality studies on the Ohio River for the Cincinnati Metropolitan Sewer District.
1989. Fisheries habitat studies below the Meldahl Locks and Dam, Ohio River. Report to Sigma Consultants/ Sithe Energies, for FERC.
1989. A wetlands survey of the Lake Forest Hospital Property, Lake County, Illinois.
1989. Environmental Impact Statement for improvements to US-131, Wexford County, Michigan. Report to Michigan DOT.
1989. Wetlands technical report Environmental Impact Statement for improvements to US-131, Wexford County, Michigan. Report to Michigan DOT.
1988. Dulles toll road extension EIS: technical report on aquatic/terrestrial ecology and water quality. Report to Virginia DOT.
1988. Roanoke circumferential EIS: technical report on aquatic/terrestrial ecology and water quality. Report to Virginia DOT.
1988. Wetlands of the Allegheny River, Pools 8 and 9 Armstrong and Clarion counties, Pennsylvania. Report to Sithe Energies for FERC.
1988. Wetlands of the Allegheny River, Pool 6, Armstrong County, Pennsylvania; Vol I and II. Report to Sithe Energies for FERC.
1988. Wetlands of the Allegheny River, Pool 5, Armstrong County, Pennsylvania. Report to Sithe Energies for FERC.
1988. PortAmerica Development Environmental Assessment. Report to National Capital Planning Commission, Washington, DC.

1988. Land use/cover for a proposed power plant, access roads, and transmission lines: Captain Anthony Meldahl Locks and Dam, Bracken County, Kentucky. Report to Mitex, Inc. for FERC.
1988. Bottom profile studies above and below Captain Anthony Meldahl Locks and Dam, Ohio River. Report to Mitex, Inc. for FERC.
1988. Environmental reports for Federal Energy Regulatory Commission Docket Number CP 88-195000: Part 1. Report to CNG Transmission Corporation for FERC.
1988. Environmental Assessment studies for CNG Transmission Corporation's proposed transmission lines TL-472, TL-474, and TL-475 in Pennsylvania. Report to FERC.
1988. Summer field survey for the Indiana bat: addendum to environmental technical report for alternate approaches to, and bridge crossings of, the Ohio River Mason County, Kentucky to Brown County, Ohio. Report to Kentucky DOT.
1988. Environmental report for revised Alternate 3 addendum to environmental technical report for alternate approaches to, and bridge crossings of, the Ohio River Mason County, Kentucky to Brown County, Ohio. Report to Kentucky DOT.
1988. Characterization of fish community structure near Allegheny River Locks and Dams 5 and 6 during 1987 surveys. Report to Mitex, Inc., for FERC.
1987. Characterization of fish community structure near Allegheny River Locks and Dams 5 and 6 during 1986 surveys. Report to Mitex, Inc., for FERC.
1987. Environmental technical report for alternate approaches to, and bridge crossings of, the Ohio River: Mason County, Kentucky to Brown County, Ohio. Report to Kentucky DOT.
1987. An assessment of the biotic effects of hypolimnetic releases from Bloomington Lake into the North Branch Potomac River. Report to Mitex, Inc., for FERC.
1987. An assessment of restricted flow on the biota of the North Branch of the Potomac River downstream of the Jennings Randolph Lake hydro-project. Report to Mitex, Inc., for FERC.
1987. Environmental assessment of proposed pipeline through Atterbury State Fish and Wildlife Area, Johnson County, Indiana. Report to Indiana Department of Natural Resources, Division of Fish and Wildlife.
1987. Environmental assessment of proposed pipeline through Camp Atterbury, Indiana. Report to Indiana National Guard.

1987. Environmental assessment for amended route for proposed construction of Texas Gas Transmission corporation's Hardinsburg-Bedford Line No. 2 and Bedford-Indianapolis 20-inch pipeline: Brown, Bartholomew, and Johnson counties. Report to FERC.
1987. Environmental assessment report for proposed construction of Texas Gas Transmission Corporation's Hardinsburg-Bedford 16-inch line No. 2 and Bedford-Indianapolis 20-inch pipeline. Report to FERC.
1987. Response to STOP's comments concerning the Texas Gas proposed pipeline in Brown, County Indiana. Report to FERC.
1987. Environmental assessment for amended route for proposed construction of Texas Gas Transmission Corporation's Hardinsburg-Bedford Line No. 2 and Bedford-Indianapolis 20-inch pipeline. Report to FERC.
1986. Kentucky Route 1638 (Brandenburg-Muldraugh Road biological assessment Mead County, Kentucky. Report to Booker Associates, Inc. for Kentucky DOT.
1986. Terrestrial biological resources U.S. 27 Campbell County, Kentucky, Cold Spring to I-471. Report to Kentucky DOT.
1986. Assessment of impacts to fish and wildlife resources at the Muskingum River Lock and Dam Number 3 Lowell, Ohio. Report to Mitex, for FERC.
1986. Fish passage studies at the Racine and New Martinsville hydroelectric projects. Vol. I, 48 pp.; Vol. II, 302 pp.; Vol. III, 280 pp., Vol. IV, 241 pp. Report to FERC.
1985. Terrestrial and aquatic sampling at the William H. Zimmer coal conversion project area. Report to Cincinnati Gas and Electric Co., Columbus and Southern, and Dayton Power and Light Co.
1985. Terrestrial/Aquatic resources and water quality of U.S. Route 13 relief route. Environmental Technical Report to Delaware DOT.
1984. EIS Follow-up study, Sandy River impoundment (structure #12), Prince Edward County, Virginia. Prepared for U.S. EPA.

8.0 Corporate Qualifications

3D/Environmental Services, Inc. (3D/ESI) is a full service environmental consulting firm that assists industry and public sector clients meet requirements of the National Environmental Policy Act of 1969 (NEPA), as amended, and other environmental regulations. We have offices in Cincinnati, Ohio and Houston, Texas.

3D/ESI is staffed with experienced and qualified professionals to assist our clients address their for the natural and human environment. In the past three years, we have completed over 400 contracts for multidisciplinary environmental services in the following areas:

- Environmental assessment and impact statement preparation
- Environmental permit support and filing assistance
- Endangered species
- Wetland studies
- Aquatic ecology and water quality
- Ecological studies
- Archaeological surveys/mitigation/documentation
- Geological investigations
- Air quality and noise studies
- Environmental site assessments (Phase I, II, and III)
- Tank removal and management
- Land use planning and socioeconomic evaluations

3D/ESI has the staff, equipment, and expertise to supply a wide range of environmental services.

Environmental Impact and Assessment Studies

3D/ESI has completed Environmental Impact Studies, Environmental Assessments, and technical ecological evaluations for a wide variety of clients. EISs and EAs determine the existing conditions of natural and human environments, identify impacts on these environments, and develop mitigation measures to compensate for unavoidable losses.

EISs are completed in accordance with the requirements of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality. NEPA projects typically require a complement of related studies, including: purpose of and need for the project; inventory and analysis of the affected environment; description of alternatives; existing conditions; impacts to physical and biotic environments; mitigation; and agency coordination. Specific areas of study include endangered species, vegetation and wildlife, wetlands, water use and quality, cultural resources, socioeconomics, geology, soils and erosion, land use, recreation and aesthetics, air and noise, and contamination.

EAs, EISs, and supporting technical documents have prepared for a variety of branches of the federal government:

- Federal Energy Regulatory Commission (FERC)
- Federal Aviation Administration (FAA)
- Federal Communication Commission (FCC)
- Federal Highway Administration (FHWA)
- U.S. Army Corps of Engineers (USCOE)
- U.S. Environmental Protection Agency (USEPA)
- State Departments of Transportation

Endangered Species, Scenic Rivers, Natural Areas

3D/ESI's biologists have completed informal consultation under the Endangered Species Act when no endangered species are present and formal consultation when endangered species may be in jeopardy. A senior biologist with 3D/ESI is a member of the USFWS Recovery Team for endangered Indiana and gray bats. Endangered species assessments, wild and scenic rivers, and unique natural areas determinations commonly require:

- Reviewing historical records and range maps for species
- Determining habitat suitability for various species
- Consultation with local, regional, and national authorities
- Conducting the project, preparing a report, and agency coordination

3D/ESI interacts on behalf of clients with state and federal agencies and private organizations responsible for protection and preservation of unique natural resources. Typical agency participants include:

- U.S. Fish and Wildlife Service
- U.S. Environmental Protection Agency
- State agencies
 - Department of Natural Resources
 - Natural Heritage Programs
 - Department of Conservation
- U.S. Forest Service
- National Park Service
 - Department of Parks
 - Department of Forestry
 - Fish and Wildlife
- Recognized independent authorities such as The Nature Conservancy

3D/ESI has completed many studies of endangered species to aid state and federal agencies, including the USFWS, meet research goals, set management goals, and assess the success of management activities. We have also completed extensive surveys for endangered species, completed mitigation of habitats lost to development, monitored the progress of mitigation, and assessed the success of mitigation activities.

Terrestrial Ecology Studies

3D/ESI has completed terrestrial ecological evaluations as part of numerous EISs and EAs on a variety of developments. We have conducted vegetation, wetland, and wildlife field studies required under by NEPA or other Federal guidelines. Project vary, but most require the following:

- Establish existing conditions of flora and fauna
- Consultation with state and federal agencies
- Assess specific habitat loss (gain) and impacts

- Develop wetland and other mitigation strategies
- Prepare environmental assessments, impact studies, and reports

3D/ESI's biologists use a variety of accepted and specialized evaluation procedures, site quality indices, and sampling techniques. Procedures, indices, and techniques frequently used are:

- Habitat Evaluation Procedure (HEP)
- Wetland Evaluation Technique (WET)
- Live, pit fall, and snap trapping
- Density, distribution, and biomass
- Radio telemetry
- Mark and recapture
- Mist netting for bats
- Statistical evaluations

Wetland Studies and Permitting

3D/ESI's scientists assist clients with wetland studies ranging from routine identification and delineation to preparation of environmental assessments, environmental impact studies, other reports, and permit applications. Typical projects require:

- Wetland delineation, mapping, and functional value assessment
- Project impact analysis/impact avoidance
- Federal and state wetland permitting
- Mitigation (restoration, creation, enhancement, and monitoring)

3D/ESI's wetland scientists are trained and experienced in wetland classification, functional value assessment, delineation, and mitigation procedures that are recognized and accepted by federal and state agencies:

- USFWS Classification of Wetlands and Deepwater Habitats
- COE Wetland Evaluation Technique (WET)
- Federal Wetland Identification and Delineation Method
- Federal Highway Administration Method for Wetland Value Assessment
- USFWS Habitat Evaluation Procedures (HEP)

Aquatic Ecology and Water Quality

3D/ESI personnel have 20 years of experience assisting clients with general aquatic resources surveys; fish entrainment, survivorship, and habitat use studies; endangered and nuisance species evaluations; ichthyoplankton studies; water quality evaluations and water quality modeling; thermal plume evaluations; bathymetric surveys; phytoplankton evaluations; and benthic macroinvertebrate surveys. We have the field and laboratory equipment for aquatic studies.

USEPA and USFWS, in conjunction with various states, have developed a variety of biological evaluation criteria for assessing the quality of surface waters. 3D/ESI has implemented these procedures and used various indices and models to assess water quality. Methods used include:

- Index of biotic integrity
- Index of well being

- Invertebrate community index
- Hilsenhoff's biotic index
- Chutter's biotic index
- Habitat evaluation procedure (HEP)
- Instream flow incremental methodology (IFIM)
- Various water quality models

In-house Capability And Capacity

Each 3D/ESI office maintains a technical library, laboratories, and computing facilities sufficient to meet the needs of a multidiscipline firm.

3D/ESI's data processing activities are supported by in-house microcomputers. We have IBM-compatible systems equipped with 80, 120, 220, or larger megabyte hard disk drives, 386 or 486 microprocessors, and 1200-baud modems. Hard copy output can be produced on any of a variety of printers from laserjet to dot matrix. IBM compatible laptop computers are used for field data entry, data analysis, correspondence, and telecommunications to the office.

3D/ESI has an extensive software library to meet the needs of our clients. The following is a sample listing of our software programs:

| | | | |
|------------------|---|------------------|--|
| Spreadsheets: | Micosoft Excel Lotus 1-2-3 | Filing Systems: | Microsoft Access Three-by-Five |
| Data Management: | SPSS(X, PC) SAS Statistix Dbase III Epistat | Word Processing: | Word Perfect Microsoft Word Wordstar |
| | | Data Transfer: | CompuServe |

3D/ESI's in-house graphic artists produce automated, mechanical, and conceptual illustrations as well as charts, maps, flow diagrams, posters, and photographic presentations. Computer generated graphics are indispensable to the services we provide. 3D/ESI employs Atlas Geographic Information System (GIS) as our mapping data base system.

3D/ESI is dedicated to developing and maintaining a complete line of modern, state-of-the-art laboratory and field equipment. We have four-wheel drive field vehicles, small mammal traps, mist nets, binoculars, spotting scopes, light and sticky traps for insects, radio telemetry equipment (transmitters, receivers, and antennas), mine lights and spotting lamps, dbh tapes, biltmore sticks, 35 mm cameras, compound microscopes and dissecting microscopes, tapes, range finders, Brunton compasses, surveyors' transits (electronic total stations and Schneider model TT-400s), sediment and soil samplers (soil corers/probes, ponar, Peterson grab and Ekman dredges, bucket augers), boats, electroshock equipment (boat and backpack), aquatic benthic and water samplers, nets (trammel, trap, gill, seines, hoop, trawl), dissolved oxygen meters, temperature meters, Ph meters, conductivity meters, current velocity meter, and Secci disks.

LIST OF CLIENTS

Corporate

| | |
|---------------------------------------|--------------------------------|
| American Electric Power | American Telephone & Telegraph |
| Columbia Gas Transmission Corporation | Conrail Corporation |
| CNG Transmission Corporation | CSX Transportation |
| Dayton Power & Light Company | East Ohio Gas Company |
| Enron Corporation | First Allied Corporation |
| K-Mart | Miles Pharmaceutical Labs |
| Marathon Oil | National Gas and Oil |
| National Steel Corporation | Nat. Gas Pipeline Co. America |
| North American Stainless | PSI Energy |
| Tenneco Gas | Texas Gas Transmission Corp. |
| Transcontinental Gas Pipe Line Corp. | Western Resources |

Federal Government

DOE, Los Alamos National Laboratory
GSA, National Capital Region
NASA
Resolution Trust Corporation
Tennessee Valley Authority
U.S. Army Corps of Engineers: Baltimore District
Rock Island District
U.S. Dept. of Agriculture, Forest Service: Hoosier Forest, Indiana
Talladega Forest, Alabama
U.S. Department of Defense: Air Force
Navy, NAVFAC
National Guard
U.S. Department of the Interior, Fish & Wildlife Service
U.S. Department of Transportation
U.S. Office of Surface Mining, Reclamation and Enforcement
U.S. Postal Service

State/Regional/Local Organizations

Baltimore City Recreation & Parks
Galveston County, Texas Water Authority
Hamilton, Ohio Department of Public Utilities
Indiana Department of Natural Resources
Indiana Department of Transportation
Indianapolis Airport Authority
Maryland Department of Transportation, State Highway Administration
Michigan Department of Transportation
Pennsylvania Department of Environmental Resources
Tennessee Department of Transportation
Virginia Department of Transportation
Washington, D.C. Armory Board

9.0 Client References

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10.0 REPRESENTATIVE EXPERIENCE

Recent EA and EIS Studies

- **ENVIRONMENTAL STUDIES FOR EAST OHIO GAS COMPANY'S ASHTABULA COUNTY, OHIO UPGRADE.** 3D/ESI assisted the East Ohio Gas Company prepare two Ohio Power Siting Board (OPSB) applications for installation of two new gas transmission pipelines in Ashtabula County, Ohio. 3D/ESI addressed the NEPA-related requirements of the short-form application and completed the entire application for submittal to the Ohio Power Siting Board. A primary concern along the proposed corridor was extensive wetlands.
- **ENVIRONMENTAL ASSESSMENT STUDIES FOR CNG TRANSMISSION CORPORATION'S 59-MILE NEW YORK STATE PROJECT EMPIRE ALTERNATE.** These studies assisted CNG meet their requirements for filing of environmental data with application for licensure by the Federal Energy Regulatory Commission (FERC). These EA Studies were completed and submitted in the FERC electronic filing format, requiring 12 environmental reports and 64-factor spread sheets for each facility segment. This project required a typical complement of NEPA-related studies for endangered species, vegetation and wildlife, wetlands, water use and quality, socioeconomics, geological resources, soils and erosion, land use, recreation and aesthetics, air, noise, and contamination.
- **ENVIRONMENTAL STUDIES FOR DAYTON POWER AND LIGHT COMPANY'S REBUILD OF EXISTING CIRCUIT NO. 6646 FROM 69 KV TO 138 KV LOGAN COUNTY, OHIO.** For these environmental studies, 3D/ESI personnel assisted the client with environmental concerns associated with replacement of approximately 15 miles of electric transmission line. The typical array of NEPA-related concerns, as they are applicable to power developments, were addressed. A report was prepared for the Ohio Power Siting Board on behalf of P&L.
- **ENVIRONMENTAL ASSESSMENT REPORT FOR TENNESSEE GAS PIPELINE'S 42-MILE PROJECT IN VERMILLION, CHAMPAIGN, AND DOUGLAS COUNTIES ILLINOIS.** These studies were completed to assist Tenneco with their filing of environmental data under NEPA for licensure application to the Federal Energy Regulatory Commission (FERC). These EA Studies require a typical complement of NEPA-related studies for endangered species, vegetation and wildlife, wetlands, water use and quality, socioeconomics, geological resources, soils and erosion, land use, recreation and aesthetics, air, noise, and contamination. An initial evaluation of the proposed corridor, completed during a helicopter flight of the area, aided in early problem solving.
- **ENVIRONMENTAL ASSESSMENT STUDIES FOR TRANSCONTINENTAL GAS PIPE LINE COMPANY: (1) LEIDY, PENNSYLVANIA COMPRESSOR STATION, (2) CARLSTADT, NEW JERSEY 0.95-MILE LINE, AND (3) 15-MILE LINE AND METERING STATION ALLENTOWN, PENNSYLVANIA LATERAL.** Three reports were prepared for submission to FERC in electronic filling format, with 12 environmental reports and 64-factor spreadsheets. The usual array of environmental concerns under NEPA were addressed: endangered and threatened species, vegetation and wildlife, wetlands, unique natural resources, land use and physiography, geology,

soils, erosion, land features, noise, air, surface and ground water supplies, water quality, alternatives, and socioeconomics.

- **ENVIRONMENTAL ASSESSMENT REPORTS FOR TEXAS GAS TRANSMISSION CORPORATION'S LOOPING PROJECT ALIGNMENTS AT (1) COVINGTON, TENNESSEE, (2) KENTON, TENNESSEE, AND (3) CALVERT CITY, KENTUCKY.** A full range of environmental concerns were addressed and included in these three filings to FERC. The projects each consisted of a facilities segment of looping transmission line. at. The segments were at widely spaced locations and were designed to boost capacity without increasing compression. Wetlands, wildlife, water quality, erosion control, archaeology, and endangered species were items of concern to the agencies. For each segment, 12 environmental reports and 64-factor spread sheets were submitted to FERC.

- **ENVIRONMENTAL ASSESSMENT STUDIES FOR TEXAS GAS TRANSMISSION CORPORATION'S 21.1-MILE MAIN LINE SYSTEM EXPANSION CLAIBORNE AND LINCOLN PARISHES, LOUISIANA.** This was a typical NEPA-type environmental assessment study to cover 21.1 miles of gas pipeline corridor lying adjacent to and paralleling to an existing line. In addition to the 21.1-miles of looping line, it was also necessary to increase compression to move the volume of gas required. The project included a normal complement of environmental concerns, such as endangered species, wetlands, noise, air, and socioeconomics. Results were provided to FERC in the 12-report format.

- **ENVIRONMENTAL ASSESSMENT STUDIES FOR TEXAS GAS TRANSMISSION CORPORATION'S 32.4-MILE MAIN LINE SYSTEM LOUISIANA EXPANSION: PHASE II.** This typical NEPA-type environmental assessment study for 32.4 miles of looping gas pipeline corridor covered all aspects of the human and natural environment, including wetlands, terrestrial and aquatic ecology, endangered species, natural areas, noise and air for added compression, socioeconomics, geology and soils, land use, and alternatives to the proposed project. The findings of the studies were provided to FERC in the electronic filing format: 12-report format and 64-factor spreadsheets.

- **ENVIRONMENTAL IMPACT STATEMENT FOR U.S. DEPARTMENT OF TRANSPORTATION WASHINGTON, D.C.** 3D/ESI prepared an EIS for consolidation of the U.S. Department of Transportation Headquarters in Washington, D.C. The EIS was completed in accordance with the National Environmental Policy Act; the Council on Environmental Quality; and the National Capital Planning Commission. The EIS (1) assessed impacts as an individual development and as part of the cumulative impacts to the area on the natural, social, economic, urban, and cultural environments; (2) developed measures to mitigate adverse impacts; and (3) aided in development of guidelines for the proposed action. 3D/ESI coordinated public meetings and public hearings, including responses by agencies and the public. The EIS included: (1) purpose of and need for the project; (2) the affected environment; (3) alternatives; (4) existing conditions; (5) impacts on the physical and biotic environments (air, noise, natural features, land use), urban systems (potable water, wastewater, stormwater, public utilities, solid waste, community facilities/services, housing, and transportation), socio-cultural and economic environments, and cultural and aesthetic resources; (6) mitigation; and (7) agency consultation.

- **ENVIRONMENTAL ASSESSMENT STUDIES FOR RENOVATION OF THE PENTAGON COMPLEX, WASHINGTON, D.C., U.S. ARMY CORPS OF ENGINEERS BALTIMORE DISTRICT.** 3D/ESI prepared an EA for improvements to the Pentagon Complex, Washington, D.C. 3D/ESI provided a description of, purpose of, and need for the Proposed Action, and an analysis of alternatives (maximum of three, including the No-Action Alternative). Existing conditions were established and constraints analyzed through interviews, reviews of previous studies, published and unpublished data, and field work. The Environmental Baseline Survey included Phase I Cultural Resources Survey. The EA is in accordance with NCPC, Federal, state, local, and COE regulations, codes, and criteria.
- **ENVIRONMENTAL IMPACT STATEMENT FOR VIRGINIA DEPARTMENT OF TRANSPORTATION AND MARYLAND STATE HIGHWAY ADMINISTRATION FOR WASHINGTON, D.C. BYPASS STUDY.** 3D/ESI assisted the Virginia Department of Transportation and Maryland State Highway Administration in the conduct of 18 public information meetings and public hearings associated with the Washington Bypass Study. The Washington Bypass Study is a regional transportation planning effort examining 465 miles of potential new interstate facilities around the Washington D.C. metropolitan area. The study examined the environmental effects of the proposed roadway, and the results were documented in a first-tier EIS.
- **ENVIRONMENTAL STUDIES FOR DAYTON POWER AND LIGHT COMPANY'S OHIO POWER SITING BOARD REQUIREMENTS FOR THE CLARKSBURG 345/69 KV SUBSTATION.** For these environmental studies, 3D/ESI personnel assisted the client address NEPA-related concerns. Of special interest were cultural resources; federal and state designated species including endangered species, threatened species, rare species, species propose for listing, species under review for listing, and species of special interest; and ecologically unique areas such as national and state forests and parks, floodplains, wetlands, designated or proposed wilderness areas, national and state wild and scenic rivers, wildlife refuges, wildlife management areas, and wildlife sanctuaries.
- **ENVIRONMENTAL STUDIES FOR AT&T'S XENIA TO CINCINNATI FIBER OPTIC LINE FOR FEDERAL COMMUNICATION COMMISSION'S ENVIRONMENTAL ASSESSMENT CHECK LIST.** 3D/ESI assisted this client with an analysis of NEPA-related environmental concerns for an Environmental Assessment. The Federal Communications Commission is the major Executive Branch responsible for environmental oversight. Of special interest were cultural resources; federal and state rare, threatened, and endangered species; and unique ecological areas such as national and state forests and parks, floodplains, wetlands, designated or proposed wilderness areas, national and state wild and scenic rivers, and wildlife refuges, management areas, and sanctuaries.
- **ENVIRONMENTAL STUDIES FOR 75-MILE CORRIDOR IN KENTUCKY TO IDENTIFY CONSTRAINTS ON PROJECT ALTERNATIVES.** 3D/ESI assisted this client with a Preliminary Environmental Assessment. The studies included an analysis of typical NEPA-related environmental concerns, such as cultural resources, endangered species, wetlands and floodplains, national forests and parks, wilderness areas, wild and scenic rivers, wildlife refuges, and unique ecological areas.

Wetland Studies

Representative Wetland Restoration/Creation Projects

3D/ESI's staff is experienced in the design and implementation of wetland restoration, creation, and enhancement projects. These projects assist clients comply with Section 404 and Section 10 permit conditions.

- **WETLAND PERMITTING, MITIGATION, AND LONG-TERM MONITORING FOR INDIANAPOLIS AIRPORT AUTHORITY: 400 ACRES AT THE INDIANAPOLIS AIRPORT.** 3D/ESI is responsible for of a multi-year wetland restoration and creation project. This project included Section 404 (wetland) and 401 (water quality certification) permitting, Section 7 (endangered species) consultation, and preparation of detailed mitigation plans to compensate for impacts to wetlands and to habitat for the endangered Indiana Bat. Implementation of the wetland restoration, creation, and enhancement plans will occur over a period of five years and monitoring will last for 20 years. In addition to the mitigation effort, 3D/ESI prepared environmental reports for wetlands and endangered species, contributed to preparation of a Master Plan EIS, provided federal, state, and local agency coordination, completed a Biological Assessment and prepared a Section 404 permit application.
- **WETLAND MITIGATION DESIGN AND IMPLEMENTATION FOR CINCINNATI/N. KENTUCKY INTERNATIONAL AIRPORT: RESTORATION AND CREATION OF 5 ACRES OF WETLANDS AT CINCINNATI/N. KENTUCKY AIRPORT, BOONE COUNTY, KENTUCKY.** 3D/ESI has completed the design and implementation of this mitigation project. This project included Section 404 Wetland and 401 permitting.
- **WETLAND MITIGATION FOR COMPLETE GENERAL CONSTRUCTION: SUMMITCREST LAKES SUBDIVISION AND 27-ACRE LAKE AND WETLAND COMPLEX, FRANKLIN AND DELAWARE COUNTIES, OHIO.** 3D/ESI has completed the design of this mitigation project and implementation of the mitigation design. This project included Section 404/401 permitting.
- **WETLAND HABITAT CREATION FOR ZARING NATIONAL CORPORATION: LAKOTA SPRINGS SUBDIVISION, HAMILTON COUNTY, OHIO.** 3D/ESI was responsible for a two-year wetland creation project.
- **WETLAND PERMITTING, MITIGATION, AND MONITORING FOR HAMILTON LAND TRUST: RESTORATION OF 5 ACRES OF EMERGENT WETLANDS AT THE PROPOSED KIESLAND BUSINESS PARK, BUTLER COUNTY, OHIO.** 3D/ESI completed the mitigation plan for this project and submitted the Section 404 permit application. Mitigation and monitoring will be completed.
- **WETLAND SURVEY AND DELINEATION FOR THE CITY OF HUBER HEIGHTS: PROPOSED CENTERPOINT 70 INDUSTRIAL PARK DEVELOPMENT, 43 ACRES IN HUBER HEIGHTS, OHIO.** 3D/ESI of assisted the City of Huber Heights with wetland permitting and mitigation design. Recently this project is approved, and implementation is scheduled for Fall 1993.

Representative Wetland Survey/Delineation Projects

- **WETLAND SURVEY/DELINEATION AND ECOLOGICAL SURVEY: I-74 AND COLERAIN AVENUE TO ASHTREE AND HAMILTON HIGHWAY PROJECT, CINCINNATI, OHIO.** 3D/ESI conducted a study to determine potential impacts to aquatic, terrestrial, and wetland resources associated with Alternative A (Modified) and Alternative B of the proposed connector. The study area contained two intermittent streams, both classified as "Waters of the United States," and regulated under Section 404 of the Clean Water Act.
- **ENVIRONMENTAL STUDIES FOR DAYTON POWER AND LIGHT COMPANY: REBUILD OF EXISTING CIRCUIT NO. 6646 FROM 69 KV TO 138 KV, LOGAN COUNTY, OHIO.** 3D/ESI assisted the client with environmental concerns for replacement of approximately 15 miles of electric transmission line. Concerns for impacts to wetlands habitats was an important component of the study.
- **WETLAND SURVEY AND DELINEATION FOR DAYTON POWER AND LIGHT COMPANY: 98 ACRE PROPOSED ASH DISPOSAL FACILITY, STUART STATION, ADAMS COUNTY, OHIO.** Field surveys were conducted to identify wetland habitats, delineate their boundaries, and determine impacts from construction of an ash disposal facility adjacent to the Ohio River.
- **WETLAND SURVEY AND DETERMINATION FOR THE SIERRA CLUB OF OHIO: PROPOSED WASTE DISPOSAL SITE, HAMILTON COUNTY, OHIO.** A study was undertaken to determine the presence of wetland habitats as described and defined in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, 1989. The purpose was to offer an opinion as to the presence of jurisdictional wetlands in a steeply sloping ravine within the project area.
- **WETLAND SURVEY AND DELINEATION FOR TEXAS GAS TRANSMISSION CORPORATION: ON AN 87-MILE PIPELINE CORRIDOR, KENTUCKY AND OHIO.** This study was conducted to identify and delineate boundaries of wetlands habitats as along a proposed pipeline corridor. The need for Federal and state wetland permits was also identified.
- **WETLAND SURVEY AND DELINEATION FOR SRI INTERNATIONAL: NEXT GENERATION WEATHER RADAR FACILITY, MARION COUNTY, INDIANA.**
- **WETLAND DELINEATION FOR SIDNEY MUNICIPAL AIRPORT: PROPOSED RUNWAY CONSTRUCTION, SHELBY COUNTY, OHIO.**
- **WETLAND DELINEATION AND PERMITTING FOR UEBELHOR & SONS: AUTOMOBILE DEALERSHIP EXPANSION PROJECT, PIKE COUNTY, INDIANA.**
- **WETLAND SURVEY AND DELINEATION FOR COMMONWEALTH FEDERAL SAVINGS ASSOCIATION: 800 ACRE BAY COLONY SUBDIVISION, GALVESTON COUNTY, TEXAS.**
- **WETLAND SURVEY AND DELINEATION FOR PROFESSIONAL ACQUISITION CORP: 500 ACRE CANE RUN SUBDIVISION, WARREN COUNTY, OHIO.**

- WETLAND SURVEY AND DELINEATION FOR ENVIRO/CONSULTANTS GROUP, LTD: 49 ACRES LOCATED ADJACENT TO EAGLE RUN CREEK, CHRISTIANA, DELAWARE.
- WETLAND SURVEY FOR BELLOMO-McGEE, INCORPORATED: PROPOSED U.S. POSTAL FACILITY, 8 ACRES ADJACENT TO MAGOTHY BRIDGE ROAD, SEVERNA PARK, MARYLAND.
- WETLAND SURVEY FOR ZARING NATIONAL CORPORATION: 43 ACRES LOCATED ADJACENT TO GLENVIEW GOLF COURSE, HAMILTON COUNTY, OHIO.
- WETLAND SURVEY AND DELINEATION FOR MILES LABORATORIES: PROPOSED FACILITY EXPANSION, WEST HAVEN AND ORANGE, CONNECTICUT.
- WETLAND SURVEY AND DELINEATION FOR LOCKWOOD GREENE: RELOCATION OF NATIONAL AMUSEMENTS CINEMA FACILITY, WEST HAVEN, CONNECTICUT.
- WETLAND SURVEY AND DELINEATION FOR HARRIS COUNTY, TEXAS: PROPOSED LOCATION OF BAYTOWN GOLF COURSE, 200 ACRES IN HARRIS COUNTY, TEXAS.
- WETLAND SURVEY AND DELINEATION FOR J.S. DAVIS COMPANY: 8 ACRES LOCATED IN ENGLEWOOD DEVELOPMENT NEAR DAYTON, OHIO.
- WETLAND SURVEY AND DELINEATION FOR NORFLEET, BROWN, AND PETKEWICZ: 6 ACRES LOCATED IN ENGLEWOOD DEVELOPMENT IN HUBER HEIGHTS, OHIO.

Endangered Plants

3D/ESI has completed numerous surveys for Federally and state threatened and endangered plants as part of larger NEPA studies, and we have also completed may project that specifically target endangered plants.

- FIELD SURVEY FOR FALSE MERMAID-WEED (FLOERKEA PROSERPINACOIDES) ALONG TEPPCO'S PROPOSED PIPELINE. A survey for this plant of Special Concern was conducted by complete walk-through during the early part of the growing season. The species is found in rich deciduous woods, especially in moist areas or around springs. In addition to surveying for the plant, areas of appropriate habitat were identified. Sampling for this species must be completed by the beginning of summer because the species is an early-season, forest floor plant that flowers and completes its annual cycle before extensive shading from forest trees.
- A FIELD SURVEY FOR PARKER'S PIPEWORT (ERIOCAULON PARKERI) AT THE CROSSING OF RANCOCAS CREEK BY TRANSCONTINENTAL GAS PIPE LINE COMPANY'S PROPOSED MAINLINE LOOP AND TRENTON-WOODBURY NATURAL GAS PIPELINE. The Federal Energy Regulatory Commission (FERC) and the New Jersey Division of Fish, Game and Wildlife required a survey for Parker's pipewort (Eriocaulon parkeri) in wetlands along the proposed pipeline corridor in Middlesex and Burlington counties, New Jersey. The pipewort is considered endangered by the State of New Jersey and is listed as a "Category 2" species by the U.S. Fish and Wildlife Service.

- A SURVEY FOR VIRGINIA SPIRAEA, A FEDERALLY THREATENED SPECIES, ALONG 30 MILES OF PROPOSED FIBER OPTIC CABLE RIGHT-OF-WAY. A field search for the presence of Virginia spiraea, and other State of North Carolina plants of special concern, was conducted by 3D/ESI in October 1992 along American Telephone and Telegraph's proposed right-of-way for a new fiber optic cable. No Virginia spiraea or other plant of special concern were identified as occurring along the proposed right-of-way.
- A FIELD SURVEY FOR RUNNING BUFFALO CLOVER (TRIFOLIUM STOLONIFERUM) ON AT&T'S PROPOSED 33-MILE CINCINNATI-WILLIAMSTOWN FT "A" FIBER OPTIC LINE.
- A FIELD SURVEY FOR RUNNING BUFFALO CLOVER(TRIFOLIUM STOLONIFERUM) ON A PROPOSED GAS TRANSMISSION LINE CORRIDOR.
- SURVEY FOR RUNNING BUFFALO CLOVER (TRIFOLIUM STOLONIFERUM) ON AT&T'S 13-MILE WILLIAMSTOWN-LEXINGTON FT "A" FIBER OPTIC LINE.
- SURVEY FOR SIGNIFICANT TREES ALONG A NATURAL GAS PIPELINE RIGHT-OF-WAY.
- A POPULATION SURVEY OF THE RARE AND FEDERALLY ENDANGERED ALPINE TUNDRA PLANT POTENTILLA ROBBINSIANA.
- A FIELD SURVEY OF BLIGHTED AND BLIGHT-FREE AMERICAN CHESTNUT TREES.
- A RARE PLANT SURVEY ON OUACHITA NATIONAL FOREST.
- SURVEY FOR SENSITIVE PLANTS OF LITTLE RIVER NATIONAL WILDLIFE REFUGE.
- SENSITIVE PLANT SPECIES OF THE "WINDING STAIRS" AREA OF THE LITTLE MISSOURI RIVER, MONTGOMERY COUNTY, ARKANSAS.
- VEGETATION MAPPING AND SENSITIVE PLANT SURVEY OF COSSATOT RIVER STATE PARK AND NATURAL AREA.
- PROTECTED SPECIES SURVEY OF A PROPOSED EXTENSION TO SANDY RUN LANDFILL, PRINCE GEORGES COUNTY, MARYLAND.
- BIOLOGICAL RESOURCE INVENTORY AND PROTECTED SPECIES SURVEY OF THE PROPOSED PLANTATION OAKS LANDFILL, ADAMS COUNTY, MISSISSIPPI.
- SURVEY FOR PROTECTED SPECIES IN THE VICINITY OF STONE MOUNDS, GWINNETT COUNTY, GEORGIA.
- A PROTECTED SPECIES SURVEY OF PROPOSED HIGHWAY 54 SUBSTATION AND 230 KV T/L FAYETTE COUNTY, GEORGIA.
- SURVEY OF PROTECTED PLANTS ON HURRICANE AND NONCONNAH CREEKS, ADJACENT TO MEMPHIS INTERNATIONAL AIRPORT.
- PROTECTED SPECIES SURVEY OF RHINE-JACKSONVILLE TRANSMISSION LINE, DODGE AND TELFAIR COUNTIES, GEORGIA.

Endangered Bats

3D/ESI has completed many studies of bats that were for NEPA compliance for federal resource agencies such as the USFWS and USFS, federal government bodies such as DOD (COE) and DOE, state resource agencies and DOTs, local government, and private industry.

- **A FIELD SURVEY AND HABITAT ASSESSMENT FOR SEVEN SPECIES OF FEDERAL AND STATE ENDANGERED BATS ON FORT BENNING GEORGIA.** This project consisted of an extensive assessment of the habitat available for bats on Fort Benning, Georgia. The study and included a netting survey to elucidate the species present. Ultimately, the data developed from the habitat studies and netting survey will be used by the U.S. Department of Defense to develop facility management plans that acknowledge the potential presence of seven species of Federal and state endangered bats on the fort.
- **SUITABILITY OF HABITAT IN THE HOOSIER NATIONAL FOREST FOR THE ENDANGERED INDIANA BAT.** The U.S. Forest Service, through the Indiana Department of Natural Resources, funded a survey to determine use of riparian and upland habitat by the Indiana Bat. Bat capture was with "stacked" mist nets, and at each net site habitat parameters were measured. The report of findings describes the occurrence of the Indiana bat and other species of bats and provides recommendations for management of forest lands for this endangered bat. Recommendations for management were based upon the results of this and similar studies in Missouri, Illinois, and Indiana.
- **IMPACT OF HUMAN DISTURBANCE ON OVERWINTER WEIGHT LOSS OF HIBERNATING INDIANA BATS.** This study was conducted with the Indiana DNR, with funding from the U.S. Fish and Wildlife Service. The Indiana bat has experienced precipitous population declines in Priority I hibernacula. One possible cause is disturbances during the season of hibernation that decrease the potential for survival without killing individual bats outright. One way to estimate the effects of disturbance is to assess weight loss at hibernacula experiencing different degrees of disturbance. If weight loss is correlated to disturbance and population declines, it may provide a mechanism to increase protection of the bat, and ultimately a key to prevent extinction.
- **FIELD SURVEY FOR THE ENDANGERED INDIANA AND GRAY BATS AT CROSSINGS OF TENNESSEE GAS PIPELINE BY THE AA-HIGHWAY.** This Biological Assessment for Federally endangered Indiana and gray bats included mist netting and habitat surveys at five crossings of the Tennessee Gas Pipeline by the AA Highway.
- **A 1990-1991 WINTER CAVE CENSUS FOR THE INDIANA BAT (MYOTIS SODALIS) IN NON-PRIORITY I HIBERNACULA IN INDIANA.** Twenty-one caves that serve as non-Priority I hibernacula for the Indiana bat were visited in January and February. There was a 35.1% increase in the number of hibernating bats. Most of this increase was at three caves, one of which reached Priority I status. Wyandotte Cave, which is the site locale for the species, also experienced a significant increase in the number of bats hibernating in the cave. This long-term increase appears to be related to gate modifications in the late 1970's that restored the natural influx of cold winter air.

- **A SURVEY FOR THE ENDANGERED INDIANA BAT AT INDIANAPOLIS INTERNATIONAL AIRPORT.** This study was completed as part of an EIS by the Federal Aviation Administration. The survey was conducted to determine the suitability of riparian and upland habitat to support the Federally endangered Indiana bat. Mist nets were used to survey for the presence of bats. A survey of potential roost trees was conducted to assess the availability of roost sites for Indiana bat maternity colonies.
- **MITIGATION FOR LOSSES OF, AND DEVELOPMENT OF SUMMER HABITAT FOR THE ENDANGERED INDIANA BAT, AT THE INDIANAPOLIS INTERNATIONAL AIRPORT.** This project consists of (1) assessing the potential of the existing habitat within the project area to meet the roosting and foraging requirements of the Indiana bat, and (2) mitigating this loss through enhancement of existing habitat, and through development of new summer habitat.
- **A SURVEY FOR THE FEDERALLY ENDANGERED INDIANA AND GRAY BATS ALONG THE EXTENSION OF INDIANA HIGHWAY ROUTE 37, PERRY COUNTY, INDIANA.** This BA, required under Section 7 of the Endangered Species Act, was completed for the Indiana Department of Transportation. It included netting for bats in summer riparian woodlands, complemented with a habitat assessment. The potential use of caves and abandoned mines within the project area by bats was assessed through mist netting, harp trapping, and bat detector surveys.
- **STUDIES OF THE ENDANGERED INDIANA AND GRAY BATS FOR TEXAS GAS TRANSMISSION CORPORATION:**
 - Development of a research design for portions of 14-mile and 87-mile lines in Kentucky
 - Field survey for and development of a habitat model
 - The presence of potential roost trees for the Indiana bat
 - Post-construction survey for endangered Indiana and gray bats along the 14-mile Indiana Gas and 87-mile Main Line Expansion projects in Kentucky.

These projects required development of a habitat model for the endangered Indiana bat that was acceptable to the USFWS and Kentucky Department of Fish and Wildlife Resources. The model is patterned after the USFWS's Habitat Evaluation Procedures (HEP) model. Field studies included paired sampling with stacked mist nets at stream crossings and an associated upland site. Habitat variables are combined with data on foraging activity and insect availability, as determined from insect sticky traps. Radio-telemetry was used to locate roost trees, and to obtain data on foraging habitat and other life requisites. A survey for roost trees and development of a mitigation plan for replacement of roost trees lost at the crossing of the Ohio River was developed. A post-construction survey was completed to ascertain the effects of construction on use of the habitat by endangered bats.
- **A FIELD SURVEY FOR THE ENDANGERED INDIANA BAT ALONG A 206-MILE NATURAL GAS PIPELINE IN ILLINOIS AND IOWA.** This project consisted of a survey of the habitat at 20 locations along the pipeline corridor, and included mist netting at 8 locations. The survey results were part of an application to the Federal Energy Regulatory Commission.
- **A FIELD SURVEY FOR AND DEVELOPMENT OF A HABITAT MODEL FOR THE ENDANGERED INDIANA BAT IN THE STATE OF INDIANA, FOR INDIANA DNR AND USFWS.**

This three-year project, consisted of an extensive netting survey throughout the northern two-thirds of the state, and development of a habitat model applicable in Indiana for this endangered bat that is acceptable to the U.S. Fish and Wildlife Service and Indiana DNR. The model being developed is patterned after the USFWS's Habitat Evaluation Procedures (HEP) model. Habitat variables are combined with data on foraging activity and insect availability, as determined from insect sticky traps and light traps.

- A FIELD SURVEY FOR SURVEYS THE SPOTTED BAT AT LOS ALAMOS NATIONAL LABORATORY. This 2 year study was completed to assist the Department of Defense with development of a database for an ecological Risk Assessment on their Los Alamos Facility.
- SURVEY FOR ENDANGERED BATS IN ABANDONED MINES IN PENNSYLVANIA FOR THE DEPARTMENT OF ENVIRONMENTAL RESOURCES. Use of abandoned mines for hibernacula by endangered bats is determined using harp traps at mine entrances. The mines are scheduled for closure, and surveys are required of U.S. Office of Surface Mining by the USFWS and state agencies.
- A FIELD SURVEY FOR INDIANA BATS AND THEIR HABITAT FOR THE ROCK ISLAND ARMY CORPS OF ENGINEERS. Four sites along a tributary of the Illinois River were mist netted to survey for the endangered bats. The habitat was recorded at each net site were and a census of potential roost trees within the project area was conducted. The location of each potential roost tree and its suitability was noted.
- A MIST NET AND RADIOTELEMETRY SURVEY FOR THE INDIANA BAT ON FORT BENJAMIN HARRISON, INDIANA. This was conducted for the U.S. Fish and Wildlife Service. Mist were used to survey for Indiana bats along Fall Creek, which runs through the Fort and was previously the a site of Indiana bat captures. Through mist net and radiotelemetry studies, habitat used by Indiana bats for roosting and foraging was identified.
- BAT SURVEY OF MINE SITES IN PIKE, PARKE, AND CLAY COUNTIES FOR THE INDIANA DEPARTMENT OF NATURAL RESOURCES, DIVISION OF RECLAMATION.
- A SUMMER CENSUS OF THE BATS OF CRANE NAVAL WEAPONS SUPPORT CENTER, FOR INDIANA DNR AND U.S. DEPARTMENT OF DEFENSE.
- ASSESSMENT OF HABITAT UTILIZATION, FORAGING BEHAVIOR, FOOD HABITS, AND DISTRIBUTION OF RAFINESQUE'S BIG-EARED BATS.
- SUMMER SURVEY AND RADIO TELEMETRY OF THE INDIANA BAT IN ILLINOIS.
- HABITAT SUITABILITY FOR THE INDIANA BAT AND GRAY BAT FOR PORTIONS OF THREE DITCHES, BIG FIVE LEVEE AND DRAINAGE DISTRICT FOR U.S. ARMY COE.
- TERRESTRIAL AND AQUATIC SAMPLING AT WILLIAM H. ZIMMER COAL CONVERSION PROJECT, INCLUDING A SUMMER FIELD SURVEY FOR THE ENDANGERED BATS.
- SURVEY FOR THE INDIANA BAT AT A CROSSINGS OF THE OHIO RIVER.

- KENTUCKY ROUTE 1638 BIOLOGICAL ASSESSMENT, INCLUDING A WINTER SURVEY FOR HIBERNACULA OF THE ENDANGERED INDIANA AND GRAY BATS.
- A SUMMER FIELD SURVEY FOR THE ENDANGERED GRAY BAT ALONG LICK RUN, FOR DRAINAGE CORRECTIONS TO U.S. ROUTE 31.
- STATUS OF THE ENDANGERED INDIANA BAT IN THE IMPACT AREA OF THE MILL CREEK RUN PROJECT (HUD) DEVELOPMENT LAFAYETTE, INDIANA.
- STATUS OF THE ENDANGERED INDIANA BAT IN THE IMPACT AREA OF THE PROPOSED INTERSTATE 69 CROSSING OF THORNAPPLE RIVER, EATON COUNTY, MICHIGAN.
- DETERMINATION OF PRESENCE OF THE INDIANA BAT (MYOTIS SODALIS) AND ITS HABITAT ALONG PORTIONS OF THE KANKAKEE RIVER FOR THE U.S. ARMY COE.
- STATUS OF ENDANGERED BATS IN THE IMPACT AREA OF PL-566 CHANNEL WORK IN MUDDY FORK CREEK, CLARK COUNTY, INDIANA FOR U.S SOIL CONSERVATION SERVICE.
- STATUS OF THE ENDANGERED INDIANA BAT IN THE IMPACT AREA OF PROJECT NO. RS-7573(1), RELOCATION OF BRIDGE NUMBER 63, SHELBY COUNTY, INDIANA.
- FOOD HABITS OF ENDANGERED INDIANA AND GRAY BAT IN MISSOURI.
- THE DURATION OF THE PERIOD OF HIBERNATION IN THREE SPECIES OF VESPERTILIONID BATS: FIELD STUDIES AND LABORATORY STUDIES.
- FOOD HABITS AND FORAGING ECOLOGY OF THE ENDANGERED BIG-EARED BAT, PLECOTUS TOWNSENDII VIRGINIANUS, IN VIRGINIA.

Endangered Birds

3D/ESI has completed studies that target specific species, and we have completed projects that examined the potential for all endangered species, as part of a larger set of environmental studies.

- INVENTORY OF SUITABLE HABITAT FOR THE RED-COCKADED WOODPECKER ON TALLADEGA NATIONAL FOREST. 3D/ESI completed a survey of 4,543 acres of forest to determine the presence of potential roost trees and to classify each cavity tree according to its potential to contain actively nesting woodpeckers. Transects were run through the forest to locate roost trees.
- ENVIRONMENTAL ASSESSMENT AND ENDANGERED SPECIES SURVEY ALONG TEXAS GAS TRANSMISSION CORPORATION'S 21.1-MILE MAIN LINE SYSTEM EXPANSION, LOUISIANA. This typical NEPA-type environmental assessment covered 21.1 miles of gas pipeline corridor lying adjacent to and paralleling an existing line. The project included a pedestrian survey for the red-cockaded woodpecker.
- ENVIRONMENTAL ASSESSMENT STUDIES FOR TEXAS GAS TRANSMISSION CORPORATION'S 32.4-MILE MAIN LINE SYSTEM LOUISIANA EXPANSION: PHASE II. This typical NEPA-type environmental assessment study for 32.4 miles of

looping gas pipeline corridor included a pedestrian survey for the Federally endangered red-cockaded woodpecker.

- A FIELD SURVEY FOR THE ENDANGERED RED-COCKADED WOODPECKER AT TEXAS GAS TRANSMISSION CORPORATION'S TIE-OVER BETWEEN THEIR BASTROP-26-INCH AND 30-INCH LINES, GRANT PARISH, LOUISIANA. 3D/ESI completed a survey for the Federally endangered red-cockaded woodpecker and assessed the value of the habitat for present and future populations to the species.
- ENVIRONMENTAL ASSESSMENT STUDIES FOR A 78-MILE NATURAL GAS PIPELINE RIGHT-OF-WAY IN ARKANSAS AND MISSISSIPPI FOR TEXAS GAS TRANSMISSION CORPORATION. These studies covered the range of requirements for an Environmental Assessment, including concerns for endangered species. A pedestrian survey was completed along the length of the proposed right-of-way, including a search for the red-cockaded woodpecker.
- SURVEY FOR THE ENDANGERED BALD EAGLE, JEFFERSON COUNTY, TEXAS FOR NATURAL GAS PIPELINE COMPANY OF AMERICA. At the request of the U.S. Fish and Wildlife Service, 3D/ESI conduct a survey for eagles at the site of a proposed natural gas metering station. The survey encompassed an area 0.5 miles in radius around the proposed metering station. The survey included a search for adult and juvenile birds, their nests, and appropriate habitat.
- FEASIBILITY AND COMPATIBILITY OF DEVELOPMENTS BY THE CITY OF COLUMBUS, GEORGIA WITH EXISTENCE OF THE FEDERALLY ENDANGERED RED-COCKADED WOODPECKER. This purpose of this study was to determine whether developments proposed by the City of Columbus are compatible with the continued existence of a population of the red-cockaded woodpeckers. Potential mitigation options to for avoidance, minimization, and compensation were developed.
- A SURVEY FOR NESTING RAPTORS ALONG A NATURAL GAS PIPELINE RIGHT-OF-WAY.
- SUMMER BIRD USE OF KANSAS WINDBREAKS
- A FIELD DETERMINATION OF POPULATION VIABILITY OF WILD TURKEYS.
- ROOSTING BEHAVIOR OF PEREGRINE FALCONS REINTRODUCED TO URBAN HABITAT.
- RADIOTELEMETRY OF FORAGING BEHAVIOR, HOME RANGE SIZE, AND NEST LOCATIONS OF PRAIRIE FALCONS AND GOLDEN EAGLES.
- AVIFAUNA AS INDICATORS OF HABITAT QUALITY IN NORTHERN INDIANA.
- TIDAL WETLAND ASSESSMENT USING BIRDS AS PREDICTORS OF HABITAT QUALITY.
- A SIMPLIFIED HABITAT ASSESSMENT PROCEDURE FOR WETLANDS USING BIRDS.

Other Endangered Species

- STUDIES OF THE KARNER BLUE BUTTERFLY AT NATIONAL STEEL'S MIDWEST DIVISION, PORTAGE, INDIANA

- Conservation Plan
- Habitat enhancement and restoration
- Status surveys.

Permitting conditions of the Resource and Recovery Act (RCRA) required National Steel Corporation to conduct studies of the potential impacts of a proposed landfill expansion on the federally endangered Karner blue butterfly. Because the species and its habitat are present on the proposed landfill site, a Biological Assessment was prepared. 3D/ESI conducted detailed vegetation, soil, and landscape surveys to assess habitat characteristics and their value to the Karner blue butterfly on both the impact and potential conservation sites. 3D/ESI developed a Conservation Plan compatible with National Steel's long-term development goals. To comply with Section 7 of the federal Endangered Species Act, the Plan and its implementation included translocation of habitat resources from the impact to the conservation site, preservation and enhancement of existing habitat, restoration of prior suitable habitat, and on-site surveys of the larval and adult stages of the Karner blue butterfly.

- **A SURVEY FOR THE BOG TURTLE FOR TRANSCONTINENTAL GAS PIPE LINE COMPANY ALONG THEIR 15-MILE ALLENTOWN LATERAL NATURAL GAS PIPELINE.** During preparation of an environmental assessment for submission to the Federal Energy Regulatory Commission, the Pennsylvania Game Commission requested a survey for bog turtles (Clemmys muhlenbergi) in wetlands along the proposed corridor. The bog turtle is considered endangered by Pennsylvania and it is a USFWS "Category 2" species. A field survey was completed to identify suitable habitat within the corridor and to search for the turtle.

- **SURVEY FOR THE REDBACK SALAMANDER ALONG TEXAS EASTERN PRODUCTS PIPELINE COMPANY'S PROPOSED RIGHT-OF-WAY.** A survey was completed for this species of Special Concern to the Kentucky State Nature Preserves Commission. This species is known from only 11 sites within Kentucky. Within the project area the species occupies deciduous hardwood forests from flat to extremely steep slopes. The species is found in leaf litter, under logs or other forest debris, and under rocks, particularly in areas of rock outcrop of either limestone or sandstone. In addition to surveying for the salamander, areas of appropriate habitat were identified.

- **A FIELD SURVEY FOR THE BOG TURTLE ON TRANSCONTINENTAL GAS PIPE LINE COMPANY'S MAINLINE LOOP AND TRENTON-WOODBURY NATURAL GAS PIPELINE.** The Federal Energy Regulatory Commission (FERC) and the New Jersey Division of Fish Game and Wildlife required that a survey be completed for the bog turtle (Clemmys muhlenbergi) in wetlands along the proposed pipeline corridor. The bog turtle is considered endangered by the state of New Jersey and as a "Category 2" species by the USFWS. A field survey was completed to identify suitable habitat and to search for the turtle.

- **BENTHIC MACROINVERTEBRATES OF STREAMS DRAINING INTO THE PROPOSED HAYSI RESERVOIR, VIRGINIA, FOR THE U.S. FISH AND WILDLIFE SERVICE.** The Huntington District COE is evaluating construction of a run-of-river reservoir on the Russell River, Dickenson and Buchanan counties, Virginia for flood control. COE requested that the USFWS Annapolis Field Office prepare a planning aid report, compare potential impacts of the project with those of a permanent pool reservoir, and discuss potential mitigation opportunities. USFWS

sampled benthic macroinvertebrate community of 11 streams; 3D/ESI processed the samples, identified the invertebrates, extrapolated invertebrate densities, calculated relative abundance, and calculated biotic indices.

- **SURVEY FOR ENDANGERED, THREATENED, AND SPECIAL CONCERN MUSSELS, IN THE OHIO RIVER NEAR EVANSVILLE, INDIANA, FOR KOESTER CONTRACTING CORPORATION.** 3D/ESI completed a survey for mussels along the Indiana shore of the Ohio River to determine potential impacts of a proposed commercial barge loading/unloading facility. Construction include the removal of approximately 80,000 cubic yards of sand and gravel from the project area. The study site was 1,200 feet long (parallel to the bank) and 500 width, at approximately river mile 783.3. Three 500-foot transects, oriented perpendicular to the shoreline, were examined for mussels. The project consisted of three principle tasks: (1) collection of samples, performed by a scuba diving crew; (2) identification of mussels; and (3) preparation and submission of a report to the Indiana Department of Natural Resources.
- **ENVIRONMENTAL AUDIT, WETLAND SURVEY, AND ENDANGERED SPECIES SURVEY FOR TRANSCONTINENTAL GAS PIPE LINE COMPANY: 1200 ACRE COASTAL PLAIN SITE, MOBILE COUNTY, ALABAMA.** As part of a pre-purchase audit, 3D/ESI conducted studies to determine the suitability of the property for commercial development. Among other concerns was the potential for endangered species, including the red-cockaded woodpecker.

Aquatic Ecology

- **ANNUAL BIOLOGICAL MONITORING OF LAKES AND STREAMS IN THE UPPER SUSQUEHANNA RIVER BASIN, PENNSYLVANIA AND NEW YORK FOR U.S. ARMY COE.** This project involved sampling for fish with boat and backpack electro-shocking, seines, and gill nets. It also required sampling with an Alpha-bottle for phytoplankton and zooplankton in lakes, and the sampling of macroinvertebrates in streams using a surber sampler and D-frame nets.
- **CHARACTERIZATION OF A STREAM, SOIL, AND BROOK TROUT AT A SITE RECEIVING DRAINAGE FROM AN UPLAND DISPOSAL SITE THOUGHT TO BE CONTAMINATED BY PCBs.** Samples were collected upstream, along a wash near, and downstream from the source of contamination. Fish body burden of PCBs is compared with Food and Drug Administration guidelines to see if a health advisory is necessary.
- **BENTHIC MACROINVERTEBRATES IN STREAMS DRAINING THE SOUTHERN MARYLAND WOOD TREATING SUPERFUND SITE, ST. MARY'S COUNTY, MARYLAND, FOR USFWS.**
- **BENTHIC MACROINVERTEBRATES OF THE MONONGAHELA RIVER NEAR PITTSBURGH, PENNSYLVANIA AND IMPACTS FROM LOW-HEAD DAM CONSTRUCTION, FOR USFWS.**
- **SURVEY FOR, AND MARK RECAPTURE STUDY OF ENDANGERED MUSSELS OF THE KANKAKEE RIVER KANKAKEE, ILLINOIS.**